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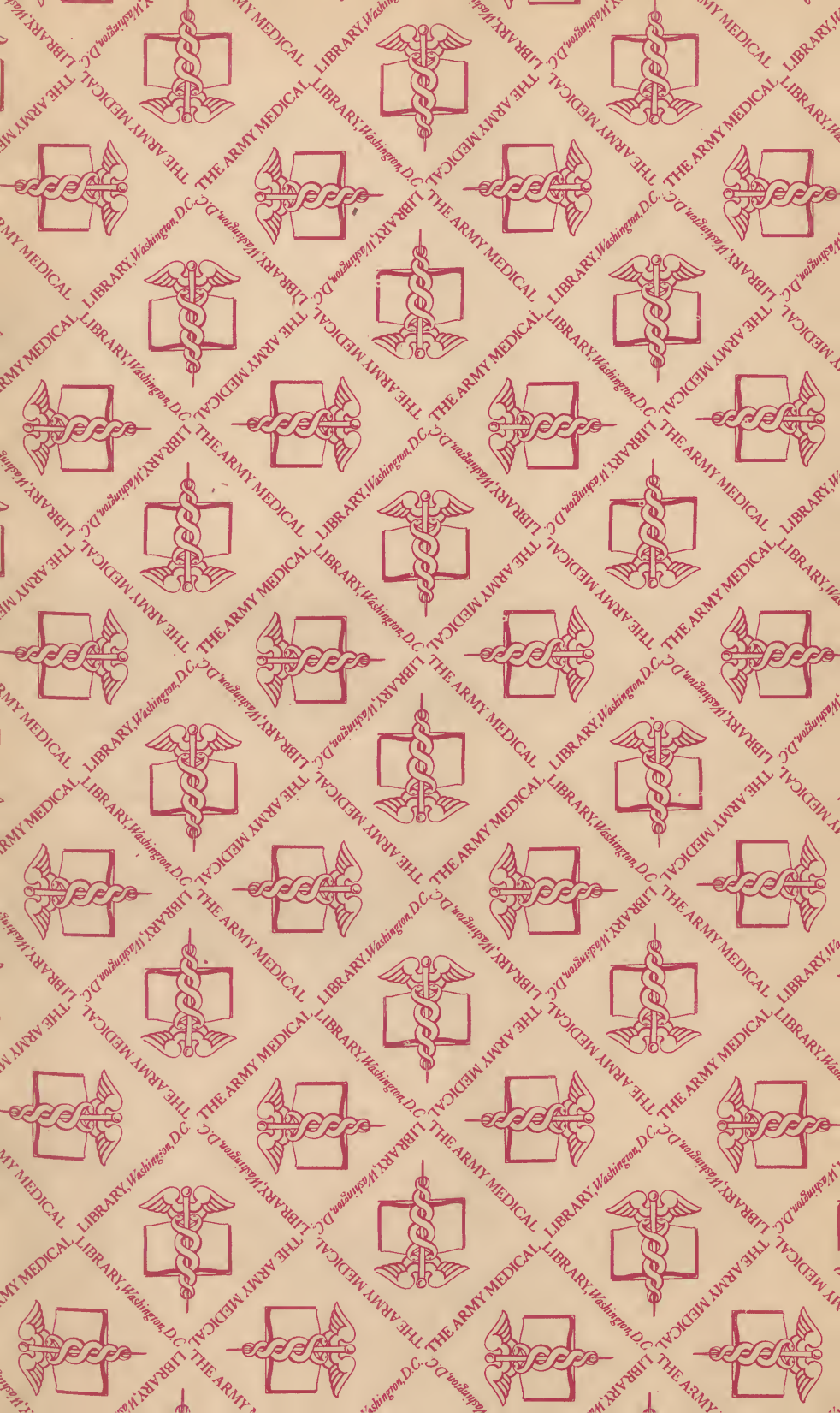
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DEPARTMENT OF THE INTERIOR
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BUREAU OF MINES
VAN. H. MANNING, Director

SAFE PRACTICE AT BLAST FURNACES

A MANUAL FOR FOREMEN AND MEN

BY

FREDERICK H. WILLCOX

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CONTENTS.

	Page.
Introduction	3
Acknowledgments	3
Accident prevention	3
The superintendent	3
The foremen	4
Responsibility of safety inspectors	5
How to attack the accident problem	5
Plant-inspection committee	5
Duties of the committee	6
Means of obtaining cooperation and recommendations	7
Foremen's committee	7
Means of putting recommendations into effect	8
Responsibility of the foreman	9
Causes of accidents at blast-furnace plants, in order of importance	9
Precautions to be observed at blast-furnace plants	10
Foremen	10
General force	12
Cast-house crew	21
Hot-blast men	32
Stove cleaners	34
Dust-catcher men	35
Stock-house crew	35
Trestle gang and yardmen	37
Pig-machine men	45
Ladle-house men	47
Slag-dump men	48
Engine-room force	48
Boiler-house force	50
Riggers, millwrights, and handymen	52
Pipe-fitters and tuyère gang	57
Bricklayers	58
Carpenters	59
Electricians	59
Cranemen	61
Notes on first aid	62
Transportation of injured	64
Eye injuries	64
Cuts, lacerations, and punctures	64
Burns	65
Fractures	66
Blows on the head or abdomen	66
Bruises and strains	67
Asphyxiation or shock	67
Publications on mine accidents and methods of metal mining	69

436034

ILLUSTRATIONS.

Page.

PLATE I. Scene in a cast house ..... Frontispiece.

FIGURE 1. Foreman warning men away from front of cylinder head of steam engine 13

2. Scrap piled at the foot of a ladder, a dangerous place to leave it 13

3. A dangerous practice, climbing between cars 14

4. Safest ways of riding on railroad car 15

5. Unsafe ways of riding on railroad car 15

6. Safe and unsafe shoes 16

7. Safety hand leather 17

8. Taking chances on a ladder, carrying bucket in one hand 18

9. Man falls from ladder 18

10. The safe way; haul up the bucket with a line 18

11. Man standing near cinder ladle 19

12. Cast-house man wearing leggings, felt hat, and woolen shirt 21

13. Unsafe method of drilling a tapping hole 22

14. Safe method of drilling a tapping hole 23

15. Safe method of operating punch-out gate 25

16. Modern runner gate operated by a cable at a safe distance from the runner 26

17. Unsafe way to stop tapping hole 28

18. Safe way to stop tapping hole 28

19. Unsafe way of wetting down trough at "rid-up" 30

20. Safe way of wetting down hot trough 31

21. Safest way of using a pole to place cars 38

22. Trestle laborer using safety pinch bar with a disk 39

23. Trestle laborer using safety car wrench 40

24. Man crawling out of hopper car through doors; an unsafe practice 41

25. Trestle laborer in ore bin, wearing belt and life line 41

26. Workman endangers passer-by in carrying bar through a doorway 42

27. Men standing dangerously close together while using picks 43

28. Workman goes away and leaves manhole uncovered 44

29. Passer-by falls into uncovered manhole 44

30. Man cutting too far beneath bank 45

31. Unsafe way of holding a bar for a sledge; man holding the bar is standing on same side as the striker 46

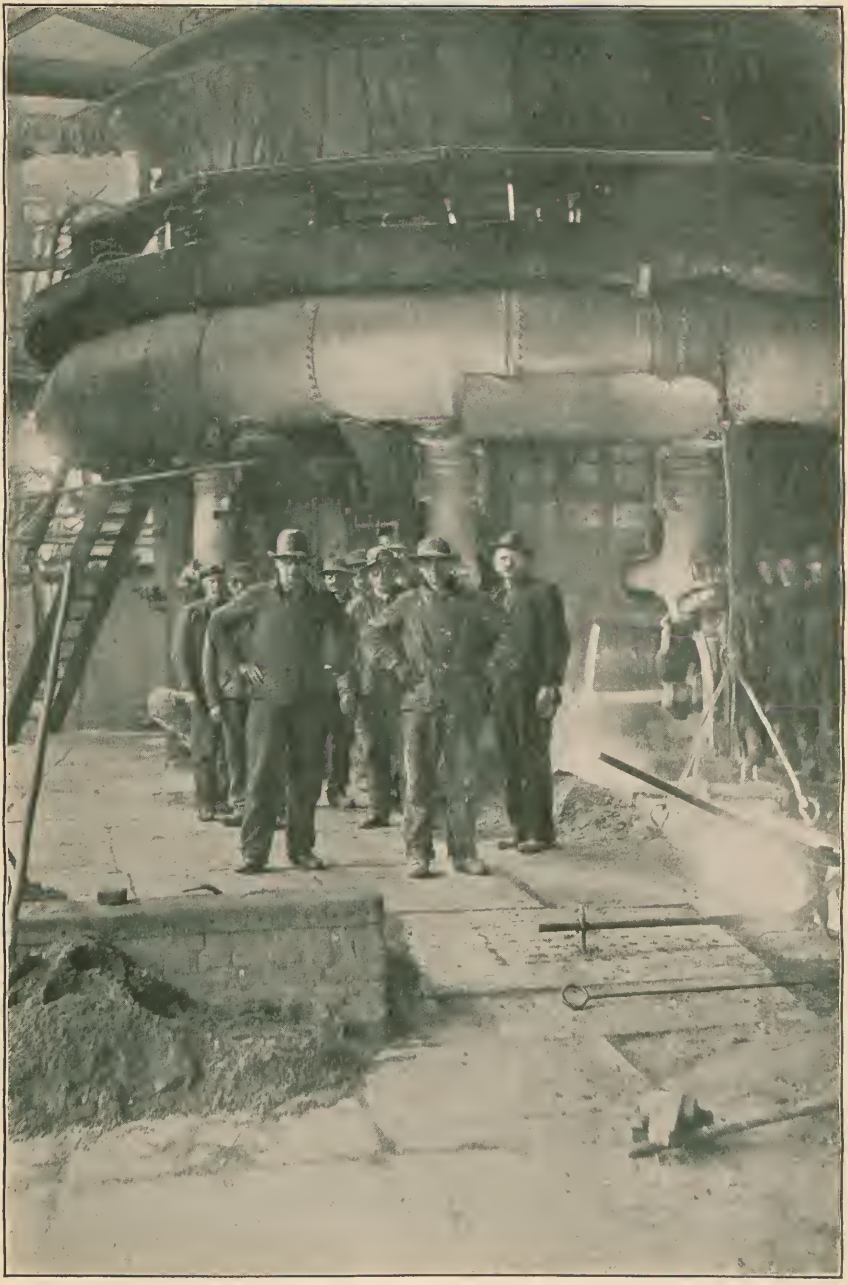
32. Safest method of holding a bar 47

33. Workman places wrench carelessly on ladder platform 54

34. Wrench falls and injures helper 54

35. Careless workman standing inside of cable bent around a snatch block 55

Page.
FIGURE 36. Workman wearing goggles when grinding tools 56
37. Workmen cutting rivets 57
38. Workman throws down board with nails in it 60
39. The result. Boards with nails sticking in them should not be left lying around 60
40. Safe way to open a switch 62
41. Electrician repairs wire with the switches in; a dangerous practice 63
42. Result of repairing wire with switches in; short circuit burns electrician 63
43. The safe way to repair a wire, switches out 63



Scene in a cast house.

SAFE PRACTICE AT BLAST FURNACES; A MANUAL FOR FOREMEN AND MEN.

By Frederick H. Willcox.

INTRODUCTION.

In its efforts to increase safety in the metallurgical industries, the Bureau of Mines is studying the causes of accidents at blast-furnace plants and methods for their prevention. This paper describes the dangers of the different kinds of work about blast furnaces and points out how the risk of accident may be lessened or avoided. The paper also contains suggestions to foremen, master mechanics, and other officials on the methods of organizing and conducting safety work.

ACKNOWLEDGMENTS.

Acknowledgment is made to the various companies that, by enabling the author to examine their plants and to study their methods of lessening accidents and by furnishing photographs, have given valuable aid in the preparation of this report.

ACCIDENT PREVENTION.

THE SUPERINTENDENT.

The following statement is addressed to the furnace superintendent, who should recognize that safety work is part of the task of a furnace-plant organization. In all efforts to reduce accidents the management should take the leading part. If officials believe that accidents can be prevented, and show a determination to prevent them, the rest of the force will reflect that attitude. Improvement in carefulness follows insistence on safety, as increase of output or reduction of costs follows insistence on efficiency, and for the same obvious reasons. In either case the management must make special efforts to effect improvement, either by employing experts or by having the department heads make special study of safety conditions, and must supply necessary funds, for rarely or never can improvement be effected without the means to make necessary changes in plant equipment. It is true that all safeguards do not pay a direct financial return by preventing the accidents for the reduction of

which they are installed. It is just as true that these same safeguards do pay when supplemented by other accident-prevention methods, because they show that the company is in earnest in its efforts to reduce accidents, by accepting the responsibility for causes entirely within its control.

If the management gives tangible evidence of its interest in safety, and consequently has aroused the interest of the rest of the force, the foremen can do more to lessen risks and reduce accidents than any other group of men in the plant. As the foremen, in plant practice, organize the force for cooperation and efficiency in plant operation, and train themselves to observe and analyze the causes of trouble with mechanical equipment or furnace practice, so is it necessary for them to organize the force and train themselves for the best results in accident reduction. Although in blast-furnace works, defective plant arrangement or design, insufficient instructions, and lack of safeguards are sources of accidents, a considerable proportion of the accidents are due to carelessness, thoughtlessness, ignorance, and clumsiness. However, men can not be expected to be always alert for obscure dangers, to adopt new practices that aim to put safety on a par with quickness or convenience, or to be thinking about not taking chances that rarely result in accident, unless their foremen exhibit as much personal interest, cooperation, and attention to details of work and equipment relating to accident prevention as they do in matters of practice.

THE FOREMEN.

To prevent all accidents about furnace plants, to eliminate them entirely, is impossible because many accidents happen by chance and are accidental in the most literal sense. To bring about a permanent reduction, however, does not require great study, analysis, or planning. The methods used to get out the tonnage, the incentives to good practice and maintenance of equipment, and the precautions against incompetence can be applied equally well to avoiding accidents from ignorance, carelessness, awkwardness, or unnecessarily hazardous conditions.

Should two or three tuyères burst, or a blowpipe and cooler burn every day, or a certain bearing get hot every week, or an armature burn out persistently every month, or a car become derailed on a certain curve frequently, some one "gets busy" and finds out the trouble, whether mechanical or personal. To make a record in tonnage, it is not sufficient to go to the blowing room and "put the wind up," a get-together spirit is necessary. If a furnace has to be taken off for repair every crew and foreman understand and cooperate in the work. Any unusual and dangerous task is given constant per-

sonal attention. Such work is not done by making a preliminary inspection, preparing recommendations, and warning the men of the hazard; one or more foremen are on the job to have the work done safely. Past experience and common sense require this. However, the percentage of accidents from asphyxiation, break-outs, explosions, or slips is very small compared with the percentage of accidents that happen in regular daily work. Dozens of accidents are repetitions of the same circumstances, the cause, nature, and result being essentially identical.

Accident prevention should be handled in the same way as operating difficulties. If it is going to cost more to pay for accidents than to prevent them, if the prospect is that every fourth, sixth, or tenth man on the plant will lose 20 to 35 days' work every year by accident and during that time be replaced by a less skilled employee who will have to be trained and will possibly cause vexatious delays and mistakes, and if better and safer working conditions attract better men, operating methods and instructions should be applied to the safety problem. The same methods that have been developed for efficiency may be used to increase safety.

RESPONSIBILITY OF SAFETY INSPECTORS.

Safety inspectors are invaluable for looking after recommendations, investigating accidents, pointing out possible improvements in equipment and methods, and organizing safety work, but if there is an inspector at the plant do not put the responsibility for betterment on him. His suggestions can no more eliminate accidents than suggestions can eliminate off-grade iron unless his recommendations as well as the foremen's are followed by improvements, detailed instructions, cooperation, and personal supervision. Moreover, if the safety inspector is not familiar with operating methods in detail, there are scores of hazardous places and practices that he will become familiar with only as accidents happen. Accident prevention is too big a job for the safety inspector unless he has the cordial cooperation of the foremen.

HOW TO ATTACK THE ACCIDENT PROBLEM.

PLANT-INSPECTION COMMITTEE.

From the subforemen and workmen a plant-inspection committee of two to four men should be selected and intrusted to inspect the plant every month on a certain date, one man being replaced each month or two months, thus keeping a working nucleus of experienced men on the committee. Each subforeman should serve on the committee, as it may be assumed that these men have obtained promotion

by displaying qualities that will be as valuable in promoting safety as in developing efficient operation. Select the workmen on the committee from those who are familiar with their work and give some promise of being permanent employees, as only a certain percentage of a plant crew can be considered a permanent asset. These men should be given opportunity to serve on the plant committee and be drawn in turn from the cast house, stock house, trestle, boiler house, and all parts of the plant.

DUTIES OF THE COMMITTEE.

The work of the inspection committee may be laid out under three heads:

1. Study of the accidents that have happened during the preceding month. After the committee has examined an accident report it should confer with the foreman in charge, the injured man, the man who caused the accident, any witnesses, and visit the place of the accident and see how the work is done. The comments and recommendations of the committee may be attached to the accident report for the superintendent's information.

2. Inspection of the plant for improper physical conditions. These conditions may include insufficient lighting, uncleanliness, refuse and débris under foot and overhead, slippery places, holes, lack of railings, overhead obstructions, poor walks, unguarded machinery, insanitation, and so on. Experience has shown that this field is the one most likely to receive attention from an inspection committee. It is unnecessary to give detailed instructions here, as in all probability 75 per cent of the recommendations of the committee will at first concern this phase of the work.

3. Inspection of the plant for unsafe practices. Especial emphasis should be placed on this feature of the committee's duties. Men engaged in accident prevention estimate the proportion of accidents due to the neglect of the worker at 40 to 70 per cent. Emphasize the meaning of these figures and encourage attention to this side of accident prevention. Insist that at least half of the time devoted to inspection be spent in observing operations, such as unloading or handling material, casting or pouring, method of using and condition of hand tools, condition of ladders, trestlework, and repair work. The big accident problem is unsafe practices, and these are largely a result of ignorance, carelessness, thoughtlessness, lack of instruction, lack of supervision, and mistaken eagerness or haste in accomplishing work by taking uncalled-for risks. Bettering methods of work as related to accidents is an unlimited field for the committee.

4. First-aid instruction. Have the men on the plant committee devote as much time as is necessary to the study of first aid, such as

bandaging, stretcher drill, and resuscitation methods. The details of this work may be obtained in Miners' Circular 23[a] and the company doctor can give the preliminary instructions.

MEANS OF OBTAINING COOPERATION AND RECOMMENDATIONS.

How much real interest is induced and how much good is accomplished by the above means are problems that largely solve themselves. Safety is a matter of common sense, foresight, and carefulness. Accident reduction is not insured by committees any more than larger production would be; their purpose is to arouse the interest of every man in being watchful. Men will feel an interest in a particular subject and pride in their own work if they are given responsibility and their advice accepted. Their thoroughness in inspection work and conscientiousness in reporting will largely depend on the attitude of the superintendent and foremen. If they treat the matter lightly the men will; if they show a desire to lessen accidents the men will respond and will take the necessary precautions.

It is hardly correct to assume that any reduction in accidents is of benefit to the workmen alone, as compensation or liability insurance are factors to be considered. Some form of appreciation of the workmen's efforts has usually been found essential and productive of results. The form which this appreciation should assume is for the management to decide. The following methods are suggested:

1. The use of a "suggestion box" in which any employee may place a signed suggestion for promoting safety. Reward the best suggestion with a substantial token such as a cash prize, watch, technical book, tool, or subscription to a trade journal. The award should be made monthly if practicable.

2. Divide the various crews under the different foremen into divisions, and to each division that has had no lost-time accidents for one to three months, or has reduced its percentage of accidents in that period, give a prize such as cigars, and award the foreman a cash bonus or a prize. In case the accident percentage rate is taken as the basis, it may be advisable to take the accumulative rate, rather than the flat rate for each distinct period. The names of those who win the awards should be posted, together with the records on which the awards were based.

FOREMEN'S COMMITTEE.

The chief foremen, such as the general foreman, master mechanic, electrician, and yard or labor foreman, and any other foremen desired, should meet with the superintendent or assistant superintendent once a month for the purpose of discussing accident prevention.

[a] Lynott, W. A., and Harrington, Daniel, Elementary first aid for the miner: Miners' Circular 23, Bureau of Mines, 1916. (In press.)

At this meeting discuss each accident that has happened during the preceding month. Find out the cause, whether negligence of employer or employee, or trade risk, and whether the accident was preventable and could have been avoided by safeguards, by instructions, by different procedure, or by more care. Use the notes of the plant-inspection committee, and if feasible have the injured man, an eye-witness, or the subforeman describe the accident and find out how he thinks it might have been avoided. Should this conference with the men be made a basis of discipline, it will discourage frankness. Discipline concerns carelessness and incompetence, and this question should be decided outside of and previous to this meeting. If the accident seems to have resulted from ignorance it should be the duty of the subforeman to explain why the man was not instructed and to see that the men are told of this danger and of a safe way of doing the work. If the accident is due to your own oversight be frank to say so; this will not destroy discipline. If the accident is clearly due to the lack of a safeguard see that the safeguard is placed promptly, though the accident may be the first one of its kind in years.

Go over the recommendations of the plant-inspection committee, note each safety measure suggested, and put it into effect immediately or explain why it is not feasible—for instance, because it interferes with something else, must be postponed until relining, may not serve the purpose, or will cost too much. It can be accepted that many railings, toe boards, guards, steps, and signs will be suggested, and that there will be futile recommendations. Before disapproving a committee's recommendation because of the cost, refer it to the management. It will prove worth while to concur in many apparently trivial suggestions, to avoid discouraging the men offering them and to encourage the submission of really valuable ideas. If a different method of work is recommended, try it if it seems practicable. If it is thoroughly impracticable or useless and can not be tried, explain why.

MEANS OF PUTTING RECOMMENDATIONS INTO EFFECT.

After the plant-inspection committee's recommendations have been accepted and approved by the foreman's committee, they should be submitted to the superintendent for approval. Approved recommendations may be put into effect in two ways. The inspection committee may locate the accident risk most thoroughly, but the design and installing of adequate mechanical safeguards is work for a skilled mechanic who has the advice of men familiar with the particular risk. To delegate the responsibility for and installation of a safeguard to a group or a committee is to make it nobody's business. Place the responsibility for this on the master mechanic.

Recommendations that deal with unsafe practices are largely made effective through education and by example. Therefore each active or past member of the inspection committee should be made to feel that it is as much a part of his daily task to work for safety by setting a good example, giving warnings, supervising the work, and contriving how to accomplish the intent of safety recommendations as it is to execute duties that relate solely to plant operation. It has been found feasible, assuming that these committeemen are selected by reason of their rank, experience, or intelligence, to make them gang safety leaders and to give them some little authority and responsibility in matters relating to elimination of accident risk in methods of doing work. If this is practicable locally, it is a more desirable recognition of committee service than a "safety" lapel button or watch fob and more effective in sustaining interest. The button or fob is useful chiefly as a token of such responsibility.

RESPONSIBILITY OF THE FOREMAN.

The final responsibility for safety work can not be placed on committees, gang leaders, or workmen. Practicable results in safety can not be obtained in that way any more than a plant can be run on such a basis. To put safety work on a sound and sensible basis the foreman must give the subject serious observation, study, planning, and direction, such as is given to operating work. The safety of the workmen always has been given foremost attention by foremen, but the reduction in accidents effected by many companies indicates that this attention has been concerned more with obviously dangerous factors than with injuries due to hand labor, use of hand tools, falls, falling objects, and similar causes incident to daily work. To these causes, however, the greater part of blast-furnace accidents is due. Following are the causes of accidents at blast-furnace plants, arranged in the order of their importance:

Causes of Accidents at Blast-Furnace Plants, in Order of Importance.

1. Hand labor.
2. Hand tools.
3. Flying and falling material.
4. Falls of person.
5. Burns from hot metal.
6. Machines and machinery.
7. Cranes, hoists, and rigging.
8. Hot water and steam.
9. Burns from cinder.
10. Flames.
11. Railroads.
12. Asphyxiation.
13. Slips.
14. Illness (including intoxication).
15. Hot flue dust.
16. Electric machinery.
17. Explosives.
18. Fighting and playing.

If "burns from hot metal" and "burns from cinder" were grouped together they would rank third. "Hand labor" and "hand tools" cause over 40 per cent of all accidents; if "flying and falling objects"

and "falls of person" are included, over 60 per cent of all accidents are represented; and if "burns from hot metal and cinder" are added the total represents approximately 75 per cent of all blast-furnace accidents. This shows where the accident problem lies. Effective prevention of accident from these causes requires study, observation, experience, and instruction. No one in the plant is more capable of doing this than the foreman, no one is in such close contact with the men, and no one can combine such work with operating supervision so advantageously and effectively.

PRECAUTIONS TO BE OBSERVED AT BLAST-FURNACE PLANTS.

FOREMEN.

The following suggestions, which cover the dangers incident to different kinds of work about the blast furnace, are not intended to serve as rules, but as useful memoranda to foremen and workmen. It is not necessary to call in the men and go through this circular with them from cover to cover; it is even of questionable benefit to call a crew together at their place of work and repeat a long string of "dont's;" precautions can better be impressed on the men gradually and at opportune times. As the precautions given in these notes gradually come to be subconsciously in the minds of both foremen and workmen at their work, to that degree will the number of accidents permanently decrease.

Avoid employing a man whose language no one of your crew can speak. Do not place a slow heavy man where a quick active one is required, or a slow-thinking man where a quick-witted one is required, nor keep on the same job a man who gets hurt frequently in that occupation unless the labor supply is inadequate or men can not be shifted. When a man is employed or put to work on a new job instruct him as to his work and how to avoid accidents, warn him of unusual or obscure danger, and then put him under the charge of the gang leader or "straw boss." You should consider yourself personally responsible for accidents that happen to your men from their ignorance of danger or of safe methods. Therefore watch for dangerous practices, ignorance, lack of skill, and carelessness, and take the necessary steps to correct faults when first noticed. Most men can be taught and encouraged to use proper methods of work, but when necessary impress on the men by admonition, warning, suspension, or discharge your attitude against carelessness or indifference. Drill your men to report immediately when injured, however slightly; send an injured man to the doctor or first-aid man, and then investigate the accident at once and discuss it with the subforeman and workmen in order to bring out clearly the cause and impress it on their minds.

Where it is possible, make dangerous places safe rather than attempt to guard them with signs. Where signs are necessary accept the responsibility for placing them, see that they are in good condition and that they are used. Make it your business to see that machinery, hand tools, tackle, scaffolds, or any other appliances are safe. Do not allow men to start or operate machinery unless they are so authorized.

Avail yourself of all safeguards provided for the men under your direction, such as goggles, leggins, and congress shoes when on duty about the cast house or pig machine. (See fig. 12.) Exhibit carefulness in necessary personal work with machinery, electrical and steam equipment, and hand tools. Place and use prescribed safeguards or signs. In this way you will be better able to insist that the men under you observe similar precautions.

Personally supervise any work involving unusual accident hazard, such as work in gas mains or cleaners, tearing out linings, work in the cast house and about the stoves when blowing in or blowing out, or in event of a bad "mess" (piles of red-hot coke, slag, or iron spilled about the furnace, or in the yard, or on the tracks near the cast house), and any work about the bells or stock line. Don't allow men to go into any place dangerous from gas, falls, or falling material without breathing apparatus, safety belts and life lines, or watchers, as the nature of the work demands and circumstances permit. Never send inexperienced men to dangerous places or set them at hazardous work. Before sending or allowing men on top or where they will be exposed to material from slips and escape is difficult make sure that the furnace is not hanging. If the furnace is working stiff or slipping, the necessary precautions should be taken in regard to checking it or taking the wind off temporarily.

Recognize that work about blast-furnace plants will still be hazardous, even after all safety measures have been taken and the force is at the "top notch" of training, skill, and carefulness. Impress this fact on the crew and insist on thorough instruction and care of every man by his gang boss.

On occasions you will have to give detailed advice and directions to the workmen concerning dangers not described in this circular. The more common dangers arise in work about gas-containing equipment, work about the furnace in event of a breakout, heavy scaffolding and slipping of the furnace, stopping the furnace, blowing in, loosing the water supply, and so on. Many other hazardous operations will occur to you. For such work a set of rules or notes intended for some particular plant conditions are futile or may even be dangerous unless varied to meet the situation. When unusual situations arise, safety depends on the measures taken by the foreman. Experience, coolness, and common sense are more essential than rules. Certain emergencies can be largely eliminated, however,

by careful examination, forethought, and planning before undertaking dangerous work. At most plants it is the rule that, before any dangerous work is done, the superintendent and foremen together definitely determine the various steps to be taken. This should be the rule at every plant.

Following are some notes addressed to men in various occupations about the plant. Many of the men will be experienced in the different positions and know of all the principal dangers and practices mentioned. With such men all that is necessary is, when you notice them becoming careless or forgetful, to show them wherein they are becoming careless. In placing new men it is worse than useless to give them a large number of instructions as they will only be confused. Keep these notes in mind and give them general instructions and any special instruction you think they need at first. Then continue to instruct them from time to time and have the "straw boss," gang leader, or subforeman do the same. Personally supervise their work as much as possible, and take advantage of every opportunity to forcibly impress on their minds the advantages of safe practice.

More and more, managements are valuing foremen by their care of the men as well as by their records for tonnage and cost. Keep the safety of your crew in mind always, and when you think of some new precaution in work or practice refer it to the superintendent at once and try to have it put into effect.

Familiarize yourself with methods of first aid and resuscitation as described in Miners' Circular 23.[a]

GENERAL FORCE.

The common and familiar accidents and their causes are mentioned in this circular. Most of these causes are so simple or obvious that there may be a tendency to regard them lightly, which is a great mistake, for they cause most of the accidents at blast furnaces. The inevitable risks natural to the work are numerous enough without enlarging on them needlessly. If the men to whose attention this circular comes will study it and follow the suggestions, lives will be saved, suffering avoided, working days gained, and jobs held, by reason of fewer accidents. Some accidents are unavoidable but most accidents can be prevented by care, thoughtfulness, and observing the suggestions made by foremen and men and in this and other books on safety.

If you see anyone in a dangerous place (fig. 1), doing anything in a way liable to injure himself or others, clumsy in the use of tools, ignorant of danger, or ignoring the use of safeguards or safety rules,

[a] Lynott, W. A., and Harrington, Daniel, Elementary first aid for the miner: Miners' Circular 23, Bureau of Mines, 1916. (In press.)

FIGURE 1.—Foreman warning men away from front of cylinder head of steam engine. If you see anyone in a dangerous place show him the danger.

FIGURE 2.—Scrap piled at the foot of a ladder, a dangerous place to leave it. Keep floor clean.

show him the danger and report the case if your warning is disregarded. Report at once unsafe equipment or tools, safeguards, or signs not in use or not replaced, and dangerous places unguarded. Watch other men's work for dangerous or unsafe methods, but be careful that your own work is done safely.

Keep things cleaned up. This is part of your work. Don't leave tools or materials on floors, platforms, or paths where they will obstruct work and make passage difficult (see fig. 2). Take time to keep the steps and platforms you have to use free from ice and to

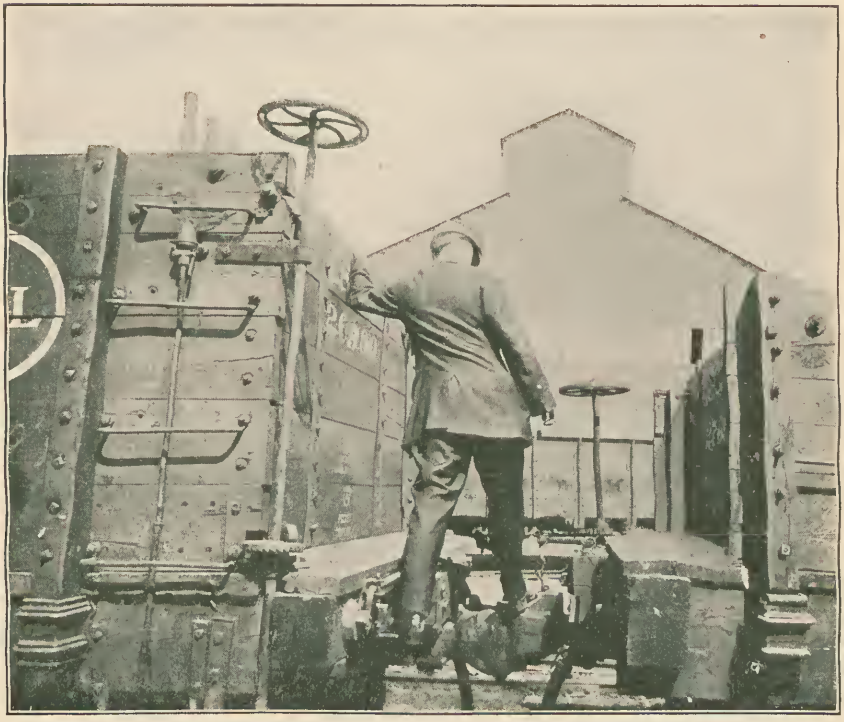


FIGURE 3.—A dangerous practice, climbing between cars.

knock down overhanging icicles. Take care of the odds and ends of lumber, scrap, brickbats, coke, limestone, and ore you find about the yard. The majority of falls are on the ground level and are largely caused by rubbish underfoot. Watch where you step. Do not walk through steamy places unless it is necessary; if you must go, walk slowly.

Don't work where your material or tools can drop without being sure that the space below is guarded by danger signs. On the other hand, don't work where you know that material may fall on you; remedy the condition if possible.

FIGURE 4.—Safest ways of riding on railroad car. Don't ride on trains unless your job requires you to.

FIGURE 5.—Unsafe ways of riding on railroad car.

In handling material such as ties, lumber, brick, bronze, castings, molds, plates, manhole covers, pipe, barrels, boxes, scrap, and pig iron, watch that nothing falls on your foot and be careful that your fingers are not caught. A large percentage of the accidents in blast-furnace plants happen in handling material. In using bars, sledges, wrenches, picks, and other tools remember that many accidents occur by men being struck with them. Glancing, slipping, and falling tools cause still more accidents. In using common hand tools more skill and care is required to avoid accidents than with many kinds of machines.

Keep off of tracks if possible. If it is necessary to cross a track look both ways before starting across. If you must cross near a

FIGURE 6.—Safe and unsafe shoes.

train keep at least a car length from the end of the train, as it may start quickly or there may be cars coming on the next track. Do not cross through a broken train unless the trainman motions you to come ahead or unless you are sure there is no engine at either end. Take time to go around a train or to wait until it passes rather than to climb through (fig. 3). Never crawl under a car. Avoid stepping on frogs, switches, or guard rails, as your foot may be caught. Don't move material with push cars unless guarded by a flag, and when working where a car might be shoved onto you have a flag guarding the track approach. Don't ride on engines, cars (figs. 4 and 5), or locomotive cranes unless your job requires you to do so.

Shoes should fit snugly about the ankle and leg, and the soles should be thick and free from holes that will allow the sole of the foot to be cut by sharp objects and protruding nails. (See fig. 6.) Whenever you see protruding nails stop and hammer them flat. In

FIGURE 7.—Safety hand leather.

handling rough lumber, sheet tin, or material having sharp edges, it is best to wear stout gloves. For handling rough scrap wear safety hand leathers (fig. 7), not gloves, because in throwing the scrap down the rough edges may catch in your gloves and cause a bad wrench or fall.

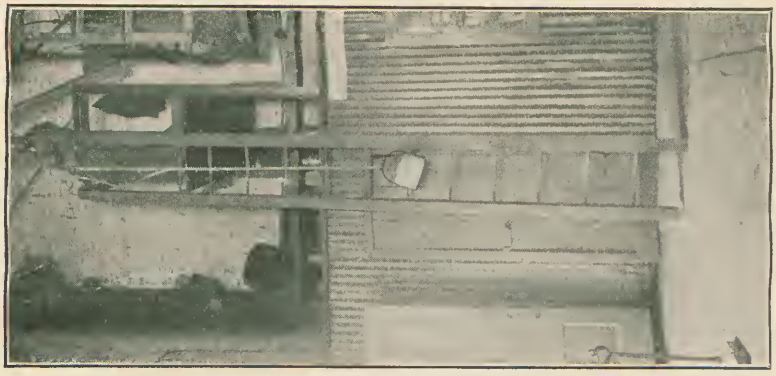


FIGURE 10.—The safe way; haul up the bucket with a line.

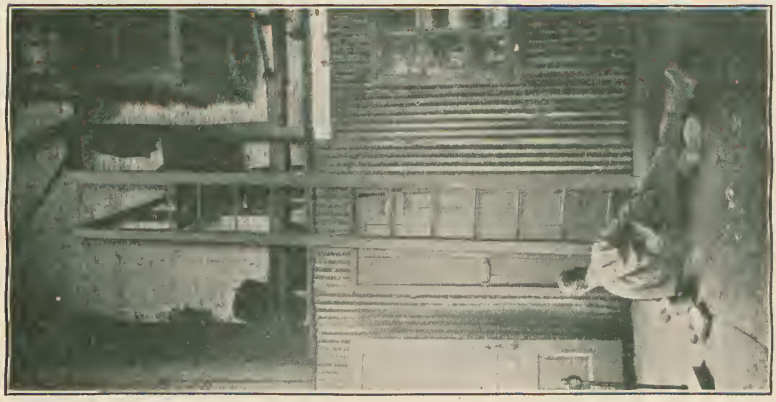


FIGURE 9.—Man falls from ladder.

FIGURE 8.—Taking chances on a ladder, carrying bucket in one hand.

Ladders should be provided with spikes or nonslipping pads and when in use should rest squarely on a level surface. Grasp the sides, not the rungs, of the ladder and face the ladder in going up or coming down. Don't attempt to slide down a ladder or to use one hand to carry tools, either ascending or descending. (See figs. 8 to 10.) Defective ladders should be taken to the carpenter shop at once.

FIGURE 11.—Man standing near cinder ladle. Keep away from cinder and iron ladles while they are being filled. They may explode or boil over.

Defective tools should be taken to the shop as soon as the defect is noticed. Do not use a sledge, hammer, pick, or hatchet that is loose on the handle, has a mushroomed head, or a split or splintered handle. Bars and wedges should also be watched, and if any defect is noticed be laid aside for repairs. When sledging stand on the

opposite side from the man holding the bar, so as to avoid hitting him. (See figs. 31 and 32, pp. 46 and 47.)

Do not meddle with electric switches, water or steam valves, or gas connections; it may cause delays and even a bad accident. Do not touch any electric line or dangling or broken wires; you may get a severe electric shock. Wear gloves when changing or cleaning electric-light bulbs. Never turn on gas, steam, electricity, or water, or set machinery in motion with which you have no regular business unless you are specifically directed to do so.

Be watchful about the furnace. Gas may be escaping in many places and may kill you before you know it is present, the furnace may slip, the bosh or hearth of the furnace may break out, a tuyère may burst, or a blow pipe burn through, or there may be an explosion. **Keep out of the cast house** except when your work calls you there. The furnace crew can sometimes tell when these things are about to happen by signs with which they are familiar; at times they happen without warning. Stay at your own work and be safe. Keep away from the bottom of the dust catchers, from under the downlegs of gas mains, and off of manhole covers of gas flues. Avoid iron and cinder ladles while they are being filled, shifted, or poured. (See fig. 11.) Do not go near a cinder granulating pit while it is in use and do not stand about gas burners or air doors of stoves. Never go on top of a furnace or gas washer unless under the direction of the foreman, or accompanied by some one. The tops of boiler settings, gas-engine basements, skip pits, and ore bins should be avoided unless your work takes you there. Before you begin work in such places, or in any place where there is a possibility of danger, wait until the foreman has told you that it is safe to go. Satisfy yourself that the place has been made as safe as possible. Never look in the peep holes of the tuyère stocks unless it is part of your duty. Always watch when passing near the furnace. Remember that frequently it is impossible for the furnace men to tell when the furnace is going to slip.

Do not refuse to use safeguards, do not ignore rules and orders, or disregard danger signs. There is a reason for each and every one. Be sure to report every accident, even the slightest burn, cut, bruise, puncture, or substance in the eye, as this may prevent a trivial hurt from becoming a serious injury. Do not set bad examples by bravado, thoughtlessness, or negligence, for less experienced men to follow. Use common sense, foresight, and watchfulness.

Those who can not read and speak English should be urged to acquire a working knowledge of the language at the earliest opportunity. By so doing they will be in a better position to heed warnings and become acquainted with dangerous practices.

CAST-HOUSE CREW.

Acquaint laborers and new men with the possibilities of slips, gas, breakouts, and bursting tuyères. If you can show them how to be less clumsy in handling tools do so, because awkward men may injure others as well as themselves. If you see anyone doing something that is dangerous or standing in some place where he might get hurt, tell him of the danger. If a man's clothes catch on fire, do not let him run. Put the fire out with a hose, or roll him in sand and smother the fire by throwing sand on it, or wrap him in a blanket or coat. If a man is gassed or receives an electric shock get him into fresh air, notify the foreman, and give him artificial respiration at once; loosen his clothing, take any tobacco out of his mouth, and keep him warm. Instructions for treating a man overcome by gas or electricity are given in Miners' Circular 23.[a]

FIGURE 12.—Cast-house man wearing leggins, goggles, felt hat, and woolen shirt. Note the "Oregon type" of sledge, with broad face.

Always wear clothes made of wool or hard jean cloth (see Pl. I, frontispiece) if possible, and especially avoid greasy clothes, as they will readily catch fire. Wear stout shoes having thick soles and without cracks or holes, that are not too low, and fit tightly about the leg (see fig. 12). Congress shoes and leggins are advisable. Wear goggles or a mask to prevent injury when handling hot metal or cinder, breaking scrap with sledges, or turning hose on hot material. Never wear ordinary gloves or hand-made hand leathers in handling jagged pieces of scrap. Leathers or gloves with a safety spring in the back are the only safe ones, as the scrap will frequently catch the glove or leather and may cause a serious sprain or fall.

[a] Lynott, W. A., and Harrington, Daniel, Elementary first aid for the miner: Miners' Circular 23, Bureau of Mines, 1916. (In press.)

When breaking runner scrap, slag, lumber, test pieces, etc., with sledges or a "Mulligan," use judgment in blocking up the pieces before breaking them. The closer the material is to the floor, the less probability there is that it will fly in breaking. When barring scrap, plates, or other objects, be sure that the point of the bar is firmly engaged, or that the bar will not slip off the block, before you lift or put your weight on the bar. Keep your working place cleaned up. Bars, drills, and long-handled tools should be kept where they will not fall and injure anyone, by preference in a tool rack. If they are leaned against the wall, place them so they can not easily be knocked over or fall down. Don't leave tools where men can stumble over them. Remove burned drills and bars promptly. Watch out for hot

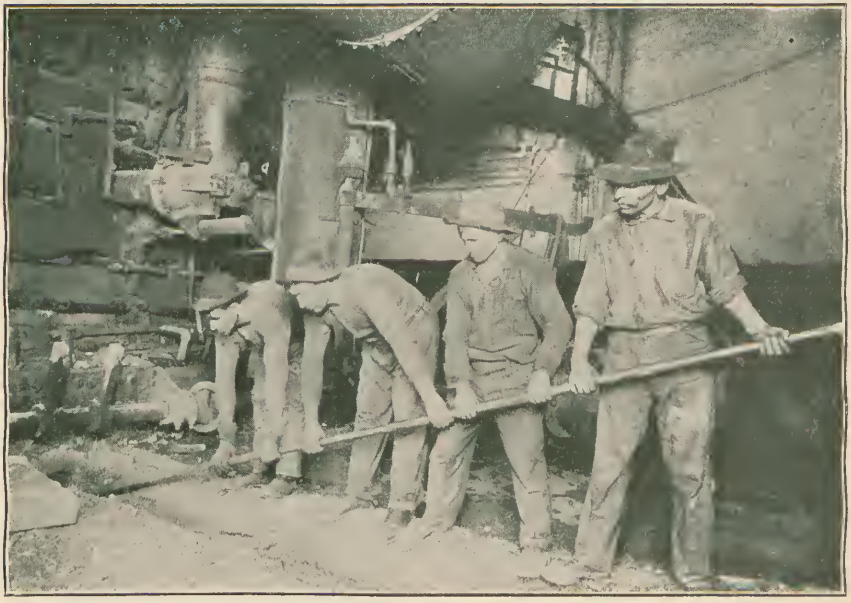


FIGURE 13.—Unsafe method of drilling a tapping hole. Men standing over open trough on planks, no shield used at tapping hole, men are wearing loose baggy clothing.

bars and don't throw bars without looking to see whether some one may be hurt by their rebounding. Be careful when the cast house is full of steam; feel your way, do not attempt to go quickly.

When a blast furnace is being blown in or blown out, banked, stopped for a time, or started up, it is more dangerous than in regular running. At such times do not rely upon your own knowledge of furnaces, but follow every direction of the foreman strictly. Do not do any of the routine duties about the stoves, dust catcher, bleeder, cinder notch, tapping hole, or tuyères except by direction of the foreman or blower.

Don't go on the bustle pipe unless you notify the stove tender, keeper, or blower. When you have to work where you can smell gas,

take frequent spells in fresh air and work with another man. Do not stay where there is gas unless your foreman knows the condition and that you are there.

FIGURE 14.—Safe method of drilling a tapping hole. Steel plate over runner, shield in front of tapping hole, men wearing proper clothing, air jet used to clean tapping hole.

Do not rest or stand under, near, or in front of blowpipes or tuyères, as they may burst or burn through and throw metal, cinder, coke, or gas over you. When you know that the furnace is hanging,

keep under cover and warn others. Keep away from the bottom of dust catchers, stove burners, downlegs, and manholes of underground flues at such times. In going to and from work avoid going under cranes carrying loads or under skip inclines, or through stock houses, boiler rooms, or places where you are unfamiliar with the work done there.

Do not try to do work other than your own about the furnace unless you are familiar with the work or have been ordered to do it. Especially do not try to help the hot-blast man on shutdowns or on work with the bleeder, mixer valve, or any regulating part of gas or blast mains unless everything you do is specifically directed by him. Many accidents have been caused by misunderstanding what some one else was doing.

Always use every safeguard provided—goggles, masks, shields, safety hand leathers, tongs, and gloves. (See Pl. I, and figs. 6, 7, and 12.) They are provided to prevent injury to yourself, and men at other plants use them. Refusing to use them is not a sign of bravery or of familiarity with your work, but rather of foolhardiness and ignorance of the danger.

Do not drive the tapping bar through the skull in the tapping hole, or go on the last spell on the drill before you have placed the splasher and put a shield in front of the tapping hole, or a cover plate or sheets over the trough, in front of the splasher (see figs. 13 and 14), except under unusual circumstances. When it is necessary to pull the tapping bar out don't hold onto the "welshman." Lay a bar across the runner to support the tapping bar while driving it out; the molten iron may rush out unexpectedly and burn you.

Do not stand in front of the iron notch when opening it; work from the side as much as possible, even on the first spell, and keep your feet out of the trough. Be especially careful when working on a short, green, hard or an unusually long hole. On changing turn, the keeper going off duty should inform the one coming on as to the condition of the tapping hole. If the hole has been working short or badly, and has not been taking the clay, the keeper should inform the other keeper and tell him how much clay was used on the last stop.

Do not cast until the skimmer, trough, runners, shutters, and spouts are dry and warm. Clay, sand, loam, or coke dust in the runners must be dry to avoid "boils" of molten iron. Do not leave pieces of cold scrap in the runners or place damp sand against the shutters or gates. Don't let pieces of wood get under the skimmer dam or drain gates, and bank up the drain or "punch-out" gates on the outside with dry sand. In filling the mud gun before a cast, only one man should do the work if the clay is being fed at the funnel, because if two men are used, one to operate the plunger and one to

feed the clay, one of them may be caught by the plunger. In loading clay at the funnel do not push it down with your foot; use a stick. However, the gun can be loaded as well and more safely by putting the clay in at the nose of the gun with a rammer. When the gun is loaded put about 3 inches of dry sand or ground ganister mixed with tar or black oil in the nose, removing enough clay to give room. Wet or sloppy clay may cause an explosion when it comes in contact with hot iron. Do not wet the nozzle of the mud gun. Daub it with black oil after casting, while it is

FIGURE 15.—Safe method of operating punch-out gate. Note the mask worn to protect man from splashes.

still warm, and again just at cast time. This will help keep it from getting wet, and will prevent a "shot" if the nose of the gun is placed in the hole against a stream of molten iron. Oiling the nose of the gun is better than warming it, because if the nose is heated too much or too long the clay will become dry and stiff, and may cause a short hole. If heating the nose is preferred, pouring one or two hand ladles of cinder over it should be sufficient.

When casting do not use cold or wet bars to poke out sand, clay, or loam in the runners or gates or to break a path for the iron. Lift the punch-out or drain gate (fig. 15) slowly to avoid a rush of iron,

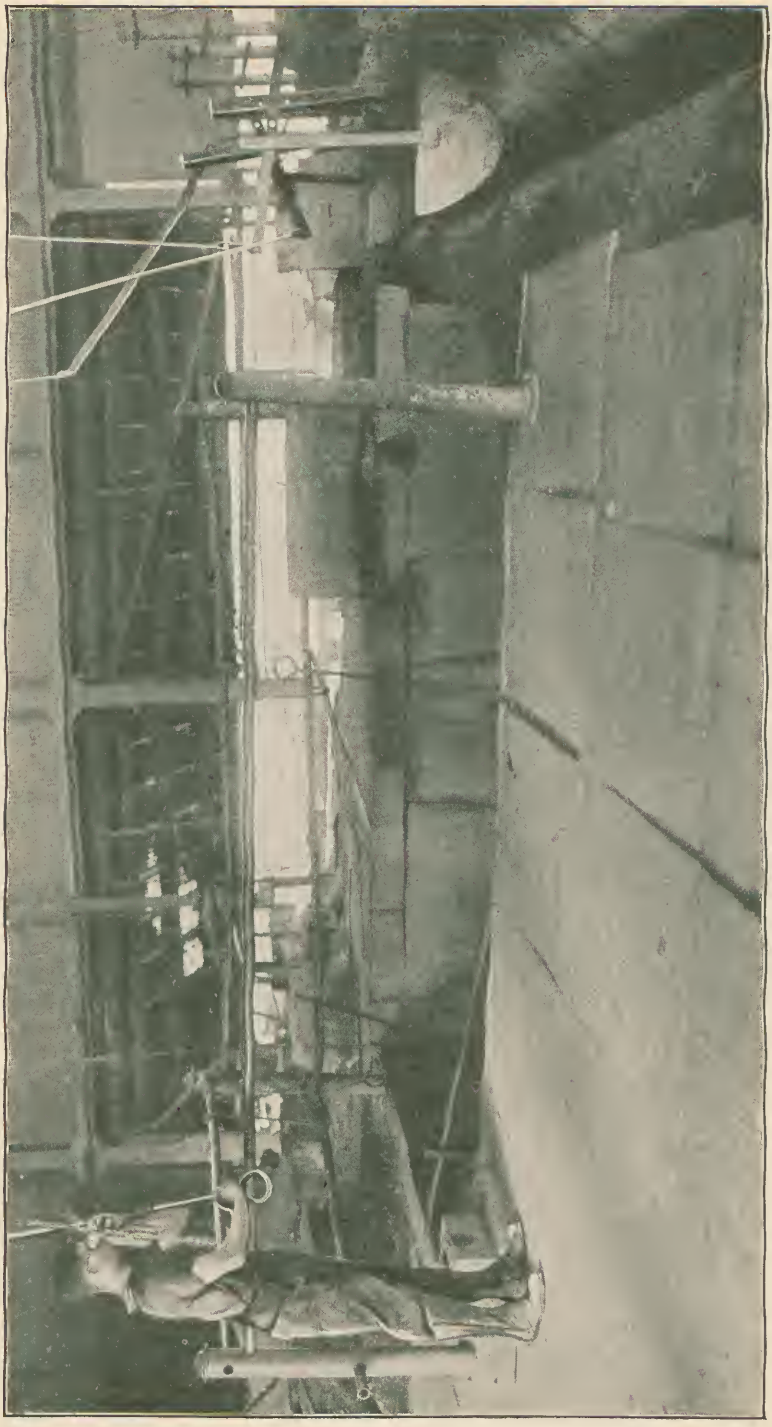


FIGURE 16.—Modern runner gate operated by a cable at a safe distance from the runner. Only part of the cable is shown.

which may cause boiling, and be sure the punch-out bar is warm. Before turning the iron into a ladle see that the ladle is spotted and is all right. Do not fill the ladle within more than 8 or 9 inches of the top, as the iron may be spilled in shifting it. Do not throw large pieces of cold scrap into the ladle before or during the cast, as it may cause boiling or an explosion of the hot metal. It is safer to fill the ladle nearest the furnace first and finish the cast in the ladles at the lower end, for several reasons. One reason is that the gates may be lifted quickly and the operator go away instantly. (See fig. 16.) If the iron is run to the bottom ladle first, be sure that all shutters are dry; if to the top ladle first, be especially sure the sand at the gates is dry. When using the pricking rod on an obstruction in the tapping hole, do not throw too much weight on the rod if standing close to the trough. Be sure that the hand ladles and chills for samples or pig-machine wheels are dry. Do not cross iron or cinder runners during a cast except when necessary, and watch your step very carefully; if you have to go in front of the iron notch, get across quickly. Do not step on the crust of hot cinder. Do not flip wet clay into hot iron to annoy or tease a fellow workman—it is too dangerous.

In stopping the tapping hole, be cautious when placing the mud gun in the hole. Unless the cinder and iron in the trough lays away from the hole, drain the trough before putting the gun in. Do not put the gun in the hole against a stream of iron unless the nose is warm and dry, as the iron may explode. After the gun is clamped, turn the steam on by the valve at the column, or by means of a long hook open the three-way cock on the gun. There is danger of gas bursting out or cinder being thrown back when the first clay is shot in. Care must be exercised in stopping the hole after the first shot, as the pressure in the furnace and the suction of the plunger may throw the clay back in the barrel of the gun and a burst of gas or slag follow. It is safer to feed the clay into the gun with a shovel rather than to stand close to the hole and trough, unless one is expert at throwing the balled clay into the funnel from a safe distance. (See figs. 17 and 18.) As stated before, use a stick—not your foot—to poke clay down into the funnel. While stopping the hole do not stand so that all your weight is on the sheets covering the trough, and watch for the exhaust steam. Do not put the wind on until the hole has stopped taking clay freely, and after the hole is stopped leave the gun in it with steam on until the clay has set; this may prevent a breakout at the tapping hole between casts. If men are changing tuyères or plates, never throw or turn water into the funnel of the mud gun or use wet clay before the hole is entirely stopped, as gas may blow out on the tuyère men. Step away from the gun for a moment when shooting water into the hole.

FIGURE 17.—Unsafe way to stop tapping hole. Helper is using his hands and standing too near tapping hole.

FIGURE 18.—Safe way to stop tapping hole. Helper is using shovel and standing away from the trough and the tapping hole.

In putting water in the skimmer trough at "rid-up" do not stand near by with a short nozzle to turn the water in (fig. 19). If the water strikes hot slag, the steam may scald you, and if it strikes a pocket of hot molten iron there may be an explosion. It is safer and just as effective to use a pipe, 15 feet or more long, turned down at the end (fig. 20). If it is necessary to break up crusts or skulls in the trough before turning water on, don't use a cold or wet bar. When handling hot scrap or slag use tongs or a hook whenever possible, and be careful in breaking or barring slag and scrap to avoid flying pieces, falls, or dropping material onto your feet. Before throwing scrap or cinder into a car be sure there is no one in it and that the pieces do not project over the end or sides of the car where they may fall or be pushed off.

Never tighten the keys on the tuyère stocks or caps, or take up slack on the bridles when the blast is on unless you are directed to do so by the foreman. Watch for tight bridle springs or split stock hangers, and don't screw up the nut on the bridle until the spring is tight. Do not start to loosen the monkey or stock bridles, hangers, keys, or caps until the blast is off and the gas is drafted back. Wear goggles when watching the peep sights during a cast or check, and do not open the peep-sight plug until you are sure no one is in line with it. Don't try to blow coke out of the eyesights until the blow pipes have had time to cool. Know where the hose and water valves are situated in the cast house, as they are needed quickly at times. When playing the hose on tuyères, blowpipes, or the furnace jacket, stand behind a column as much as possible, or to one side, as they may burst or burn through. In case a tuyère bursts or a blowpipe burns out do not work about them unless thoroughly familiar with the danger. Work to one side as much as possible when dropping blowpipes, claying up, and changing tuyères, as cinder, coke, or gas may blow out. The tuyère opening should always be firmly plugged with clay as soon as the blowpipe is dropped. Never work about an open tuyère or plate when water or wet clay is being put in the tapping hole. Watch for hot bars, blowpipes, and scalding water or steam. Do not put up the blowpipes after a shutdown until the foreman orders you to, for unless the blowing engine is turning over it might cause an explosion. Don't look into a blowpipe when cutting out clay after a stop.

When "botting up the monkey," or plugging the cinder notch, wear goggles or a mask and long leather gloves; be sure of your footing, and always use the shields provided. Work from the side of the cinder notch as much as possible when opening it, and when breaking cinder in the runner during a flush keep out of line with the cinder notch and be careful the cinder does not splash on your feet. Cinder will splash farther than iron. Keep as far away as

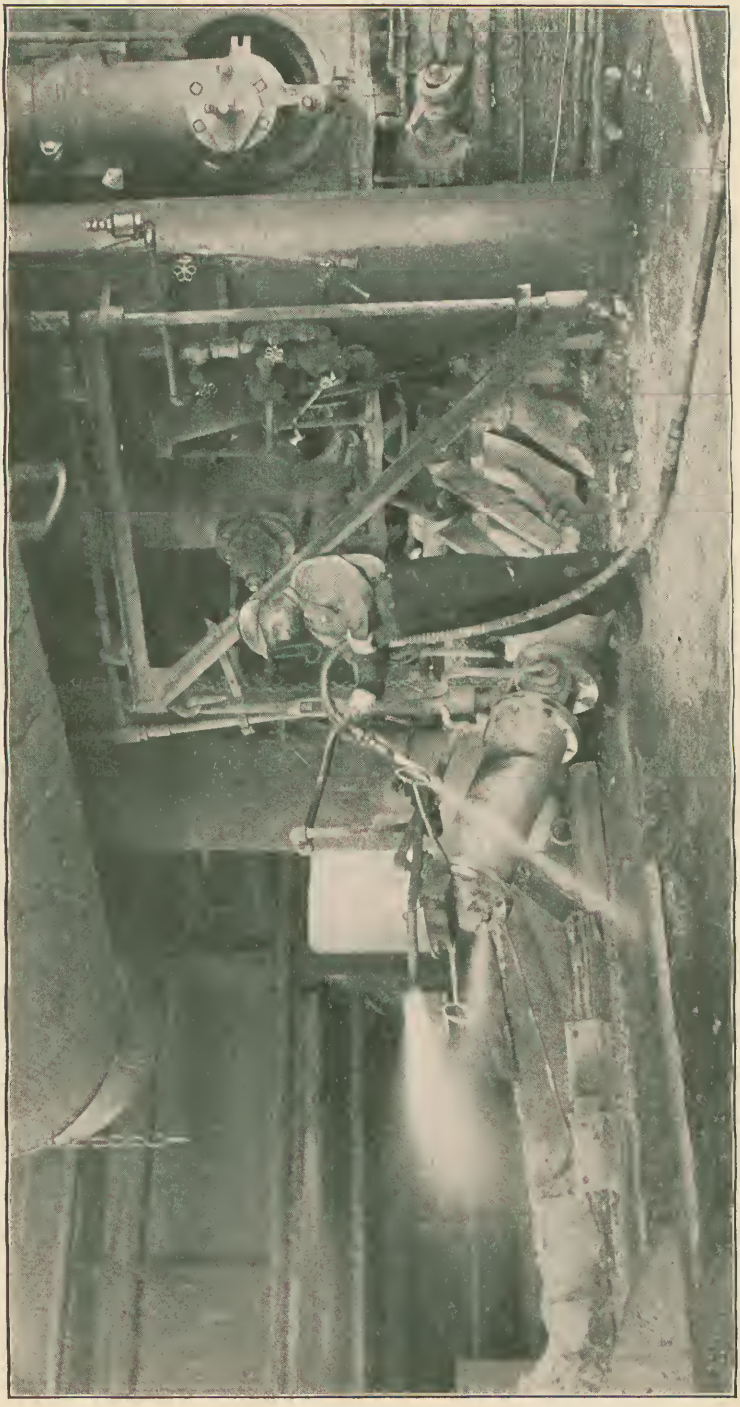


FIGURE 19.—Unsafe way of wetting down trough at "rid-up." Short nozzle on the hose, man standing close to trough where he is exposed to an explosion of hot metal or steam.

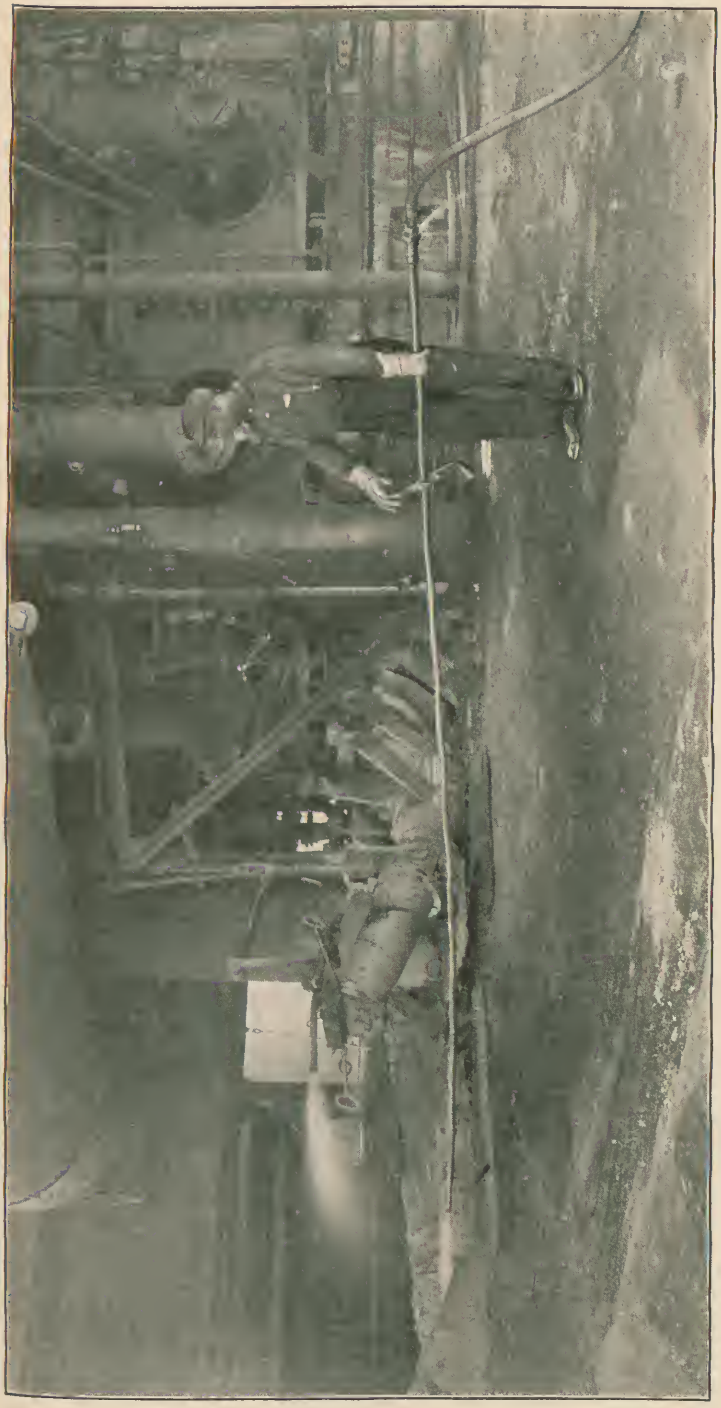


FIGURE 20.—Safe way of wetting down hot trough. Extension nozzle on hose, man standing away from the trough.

possible when throwing coal in the cinder runners. It is just as well not to throw coal into stiff cinder, as it does not greatly help matters.

Do not throw damp or wet rubbish in the cinder ladles, and always examine them for water or dampness and dry them out with cinder before flushing or casting, because a damp ladle may boil or explode when being filled. Keep away from the granulating pit when the skimmer trough is being drained or when you think iron is coming over the cinder dam. If it is necessary to plug a cinder ladle with clay, always place a sign or station a watcher before going into the ladle. Be sure there is no one in a car or ladle before throwing rubbish into it.

Be prompt to report anything abnormal or unusual about the furnace—for instance, the blast pressure becoming high or low; hanging, tightness, or slipping of the burden; cold or dirty cinder; sloppy, dead, or leaking tuyère; gas lighting on the bosh or about the mantle; hot spots on the shell; delays in filling the furnace or in spotting iron or cinder ladles; wind and gas leaks; or signs of a break out, such as steam or gas coming from about the jacket, columns, or pavement, the water getting hot or steamy in the discharge from the hearth or bosh jacket or on the jackets, or the pavement or columns getting unusually hot. Especially, report promptly any signs of the cooling water supply becoming slack. Neglect of these points oftentimes leads to unnecessary hard work and danger from "messes," breakouts, slips, burned tuyères and blowpipes, or explosions. The foremen are looking for these signs also, but one man may not see all of them.

HOT-BLAST MEN.

Be careful that the gas or blast is not turned into or gas drafted back through a stove that is being cleaned. Do not open or close any doors or valves or remove any signs or locks on such stoves until the foreman has told you to do so. Before turning gas into a stove, warn any well-bottom cleaners working about the doors, as it may flash back when it ignites; and be sure that the chimney valve is open. If you think that the stove is not hot enough to light the gas, put a large bunch of burning waste at the gas door or provide other means to ignite the gas. Don't stand by the burner after turning gas into the stove; step away quickly. At times the gas will not light until it reaches the top of the well or combustion chamber, and it is then likely to light explosively and puff out through the burner and air doors. Be especially careful when you are turning on gas from a furnace just blown in or from one shut down on account of leaky "bronze" (tuyères, coolers, bosh plates, cinder monkey, etc.). In case of doubt always use burning waste; don't let the stove fill with gas and then try to light it. If the stove

does not light, shut the gas off and start over again, using burning waste.

Before you blow off a stove, warn men to keep away from the blow-off valve, and especially warn them away from the blow-off door if the stove is being shut down for a leaky tuyère, as the gas may be very explosive. Be sure that the blast is on the new stove before shutting the cold-blast valve of the stove being taken off. Don't let the hot-blast valve drop sharply onto its seat and don't let the blast slam the chimney valve into place; set the valves easily by hand. Open the cold-blast valve slowly to avoid racing the blowing engines.

In case of the blast stopping unexpectedly from any cause shut the mixer valve on the by-pass at once, then close the cold-blast and hot-blast valves as soon as possible. Never forget to close the mixer valve before checking or shutting down the furnace, beginning a cast, or stopping the blowing engine. To forget to do this may cause an explosion that will wreck the mains and engines. When it is necessary to take the stoves off during a shutdown to "change bronze," or for a short stop, be sure the burners are closed tightly. When ready to start the furnace and bring the gas down, never turn the gas into the stove until the blower has given the signal. Be sure that the explosion doors or bleeders on the gas mains or dust catcher are closed during a shutdown; if any air gets into the mains there is always a chance of an explosion. Whatever way the blower tells you to handle the top bleeder, whether to keep it open or shut during a shutdown, always follow his order to the word. Many serious furnace accidents are caused by operating bleeders and gas valves other than in the way ordered. The least change from orders may cause a terrific explosion. If the gas is "wild" in drafting it back in one stove at a shutdown, draft back through an additional stove at once.

Keep away from the dust legs and manhole covers on gas mains, from gas burners and air inlet doors, when the furnace is sticking and liable to slip. Be careful when you open an air door to see how the gas is burning; if too much gas is turned on, or if the checkerwork is dirty, the gas may flash back into your face. Keep and warn others away from these places; no one should handle burners, doors, or valves unless directed by the stove tender. Do not tighten any thumb or other nuts on doors or blow-off valves when the stove is on blast; you may be killed or injured by the bolt breaking. Watch the water on the hot-blast valve and seat, because water leaking into the stove may cause the furnace to slip or get cold; it will then be more dangerous. Report any gas leaks about the burners or mains; do not let them leak unnecessarily. When

the millwright is examining the chimney valve for leaks do not change the stove from blast to gas. When the hot-blast valve and seat are being inspected be sure the chimney valve is kept open and the gas turned off.

STOVE CLEANERS.

Before entering a stove to clean it, lock the cold-blast valve and gas burner shut, fasten the chimney valve open, and either block the hot-blast valve in its seat or disconnect the cable from the stem, or lock the windlass, and attach danger tags; be sure these things are done. Stop any leaks about the burner with clay as even a small leak may allow considerable gas to drift into the stove. It is always safest to close the burner door, but if this can not be done for any reason, turn the burner on its seat, away from the door or seal it off with a blank. When ladders must be used to get into a stove through the dome manhole do not try to carry tools up or down the ladder, use a hand line. (See figs. 8 to 10.) Keep away from the well of the combustion chamber and do not sit on the bridge wall between the well and the checkerwork; the wall may give way. Boatswain's chairs for cleaning, tearing out, or repairing the well lining should be supported by tackle attached to the top of the stove shell when possible, and the chair, rope, and tackle tested to double a man's weight before use. Anyone working in a boatswain's chair should wear a life belt attached to the chair-sling block. Do not use a torch inside a stove; use an electric light on a standard insulated extension cord and have an electrician make all connections. When it is necessary to clean checkerwork from the bottom or to clean out under the arches keep under the arches as much as possible to avoid bruises from falling brickbats, clinkers, or tools. It is best never to enter the bottom until everyone is out of the top. Always wear goggles when inside a stove and do not remove the locks from the valves until everyone is out and the manholes are closed. In cleaning flue dust from the bottom of a stove be careful to avoid burns; the dust is usually hot and easily runs into one's shoes. Notify the stove tender, before opening the cleaning, air-inlet, or blow-off door to clean the well from the outside, and have him turn the gas off enough to avoid any danger of flame puffing back through the door at which you are going to work. In case the furnace is hanging, stop work until it slips and keep away from the cleaning door. In loading barrows with hot cinder or dust do not fill them so full that they will run over; handle them carefully, and warn others to keep out of the way. Bars and cutters used in cleaning wells should be handled with crossbars when withdrawing them from the stove. Keep away from the doors when gas is being turned in the stove.

DUST-CATCHER MEN.

Empty the dust catcher regularly; if you let it get filled and the furnace slips, there may be an accident. Notify the foreman when the car is full and if the car is not moved promptly and an empty one spotted. Never dump the dust catcher when the wind is off the furnace or when the furnace is hanging or liable to slip unless you are doing it under the orders and directions of the foreman or superintendent. In dumping dust legs, dust pockets, or dust catchers be sure there is no one underneath to get burned, and warn men against approaching, as the dust may fly and burn them. Be careful in cleaning up dust and never step on it, because it will run like water when hot, and burn you severely if it gets in your shoes. Be cautious in playing a hose on hot dust, as it sometimes explodes or flies. Do not clean up under the dust catcher unless you have notified the foreman and he has told you to go ahead; the bell may be forced open by a slip or by being overweighted and the dust may burn you. For the same reason never go into a dust car after it is spotted under the dust catcher; pack the doors before the car is placed. Turn the water on full before you open the bell, and water the dust thoroughly when dumping the dust catcher. Don't fill the car with hot dry dust and then turn the water on; it will soak down slowly, and the contents may explode. Always place a card on the car so that the unloaders will know they are handling flue dust.

STOCK-HOUSE CREW.

Rod the furnace regularly and in case it is hanging or stiff report to the foreman promptly. If anyone is working in the skip pit, on the skip incline, hoist, or skip, don't move the skip, except under direction and after giving warning. If an oiler or "handy man" is working on the sheave wheels, bell rods, hoppers, distributor mechanism, or bell-rod cylinders, do not lower the bells except on signal from those on top. Never start the skip or hoist cage until you receive the proper signal, unless you have all regular charging operations in sight, and then signals are not required. When the blast is off, or when the furnace is shut down and men are working about the top or bottom, do not fill the furnace or lower the bells without warning the men away from the tuyères and hoppers on top, and then only under the direction of the foreman. If the furnace is being shut down or if it is working irregularly and stops taking charges on account of hanging and slipping, do not put wet ore on the bell; at many plants it is considered dangerous to dump wet ore when the furnace is low. Report anything about the skips, bells, or indicators that does not seem right, such as skips striking the

bumper blocks too hard, slack or frayed cables, irregular, slow, or quick movement of the bells, or water in steam lines. By early notice an accident or possibly a hazardous delay may be avoided. Never let anyone go up the skip incline to the top alone.

Scale-car operators should watch for stock-house cleaners or others crossing the track and should always have the car under control. Watch out for overhead obstructions. Let the furnace millwright or electrician do all repair work on the car. Be careful not to leave ore or stone on the edges of the chutes; many accidents are caused by stock falling from the chutes. When barring or punching at the chutes or doors of the bins be careful to avoid a rush of ore or stone falling on your foot. Do not open the door of a nearly empty bin or get under it just as the car doors are dropped on the trestle; the material may easily fall through and bruise you, or if it is flue dust or sinter, burn you. Wear goggles when the coke is very dusty or when breaking ore or limestone. If steam is used to thaw ore in the bins or piles be sure that the hose is strong and in good condition. See that no one is in line with the nozzle when you turn the steam on. If gas is used see that it stays lit and that a pocket of gas does not accumulate. Do not light gas by hand with a match, use burning waste, placed on the floor or in the chute.

Most accidents with ore buggies happen from catching the fingers between the buggy handle and a column, wall, or other obstruction. Watch out for this and use safety handles. Be careful not to let the buggy leg come down on your heel, or to run the wheel over someone's foot. Never race with a buggy, you may easily lose control of it and receive a wrench, strain, or bruise. Watch that your fingers or feet do not get caught between a lump of stone or ore from the chute and the buggy or floor. Don't undercut an ore or stone pile, or let the stock lodge above you, keep it knocked down with a bar. (See fig. 30, p. 45.) Never stand close to the elevator pit as the cage comes down, ready to take the buggy off the instant the cage comes to rest, as many men have had their feet crushed in this way by getting them caught between the cage and the floor sill. Don't try to get on the cage before it has come to rest, or after the signal for hoisting has been given.

When it is necessary to clean the skip pit, notify the skip operator and do not go into the pit until he tells you to. Avoid walking under bin doors and chutes. Keep off the scale-car track and watch for the car when crossing the track. Don't stand on the track when signaling the car operator. Be careful that your bar does not touch a third rail or trolley wire. It is best not to ride on the scale car, and you should never jump on or off the car when it is moving.

When you enter the motor house or hoist-engine room notify the skip operator, both on entering and leaving. Stay at your own place

of duty, even when you are "spelled off." Keep away from the cast house and stoves unless you are required to go there to help. Report all bad places to the foreman, such as dark corners, overhead obstructions, poor track, holes, and unsatisfactory bin doors. Be sure to report every injury, as even a slight injury if neglected may have serious or fatal results. Even a bit of coke dust may seriously injure the eye if not taken out right away. If a man receives an electric shock free him from the source of current, being careful not to get a shock yourself, give him artificial respiration at once according to the method described in Miners' Circular 23[a] and send for the foreman. Similar first aid is needed if anyone becomes gassed while working on top.

On hand-filled furnaces top fillers should remember not to step over trap or lift doors at the top of elevator shafts while the elevator is running.

The safety of many men about a furnace plant depends indirectly on the care and interest the stock-house crew take in their work. Careful weighing, regular charging, reporting any difference in appearance or quality of coke or limestone, and constant watching of the movement of the charge in the furnace will prevent many slips, "messes," and dangerous work at the tuyéres, tapping hole, and furnace top.

TRESTLE GANG AND YARDMEN.

Watch for the lorry car, locomotives, and cranes and do not go under the ore bridge just before ore is dumped into the bins. Do not jump on or off moving cars; many men are hurt that way every year. Never sit on or near the track or bridge rails to rest; find a safe place. When you hear the warning whistle at the furnace get out of the car at once and under shelter as it means the furnace is hanging and may slip. When ore is being dynamited and a warning is shouted, get under cover and stay there until material has stopped falling. Do not try to jump across the bins from rail to rail; use the crossovers. They were put there to use and the minute saved by not using them is worth less than the good example set by using them.

Do not use a pole in spotting cars with a transfer car or locomotive on an adjoining track, use a cable with safety hand locks. If there is no cable and a pole must be used, stand on the same side of the pole that the coupler of the car is on (fig. 21). Be careful in pinching cars on the trestle, you may fall and receive a severe injury. Pinch a car the way the foreman has shown you, and report pinch bars with smooth heels or dull points to the toolman or foreman. The

[a] Lynott, W. A., and Harrington, Daniel, Elementary first aid for miners: Miners' Circular 23, Bureau of Mines, 1916. (In press.)

safest pinch bar (fig. 22) is one fitted with a disk and tool-steel heel. When turning on a steam jet to thaw ore see that no one is in line with the jet; use a clamp to hold the nozzle, and avoid working with worn hose. Watch that cinders from trestle locomotives, or hot coke, do not start fires in the coke bins or walks.

A safety car wrench for opening drop doors on cars is shown in figure 23.

It is dangerous to open drop doors on loaded cars unless you know how. Do not try to do it until you have been shown and, if possible, have watched for a day men who know how. Before getting into a car to unload it, or crawling under a car to work on the drop doors,

FIGURE 21.—Safest way of using a pole to place cars.

make sure, by asking the foreman or "straw boss," that the car will not be moved. Wait until the doors are dropped before going on top of material in cars to be unloaded. When unloading hopper cars, do not stand over doors or on the edge of the material; it may slip and carry you down into the bin where you may be suffocated or severely injured. Obtain a firm footing in the bottom of the car between the doors, or be sure of a firm hold on the side of the car. By all means wear a belt and safety line if these are provided. Do not undercut material any more than is necessary and watch that the lumps do not catch you. Be very cautious in opening the doors of cars loaded with flue dust; if dry, it will fly out. Avoid stepping

on flue dust in cars, for even apparently wet dust may be dry and hot beneath and cave when you step on it. Always get out of a car the same way you get in; do not crawl out through the doors in the bottom of the car (fig. 24).

Before you drop material into empty or nearly empty bins notify the stock-house crew so they can keep clear of falling material, and

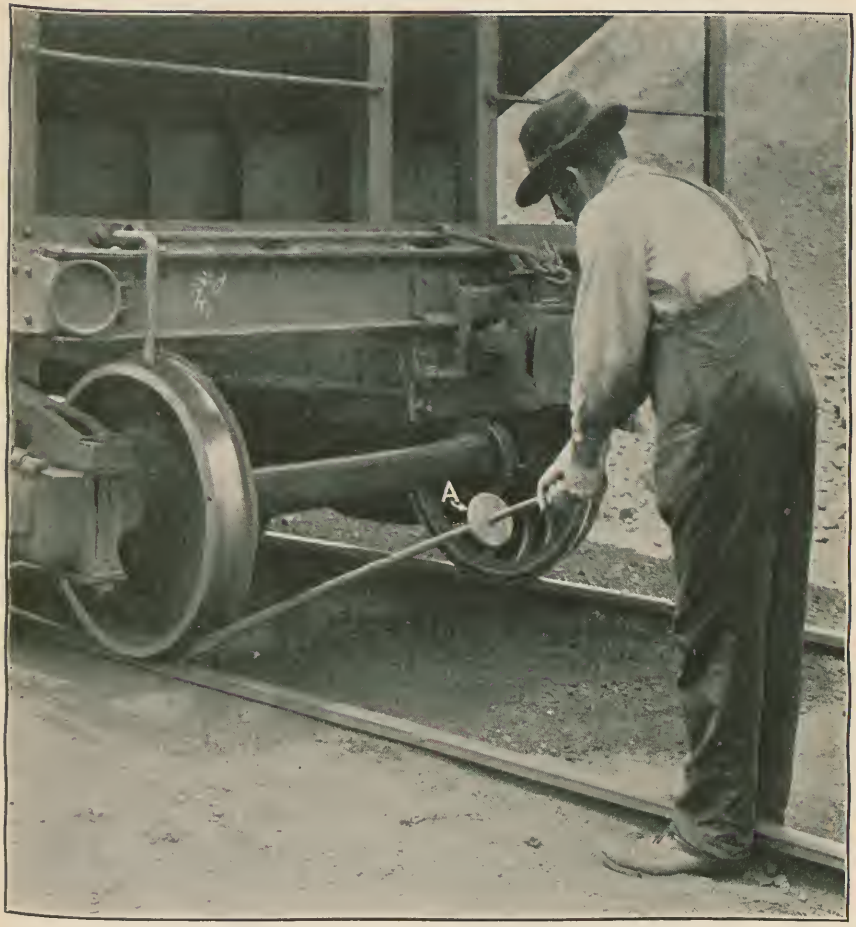


FIGURE 22.—Trestle laborer using safety pinch bar fitted with a disk, A. Should the bar slip his knuckles will be protected.

be sure that the bin doors are closed. In poking ore in bins and chutes see that you will not get caught in case a fall of ore catches the bar. Never go into any bin to shovel material or to clean the bin unless you have a belt with a life line attached to a girder or tie (see fig. 25). Use a flag or track torpedo to protect the bin you are working in, or ask the foreman for a watcher to hold the line and warn men not to dump material in the bin or run cars over it.

Do not work with a pick or sledge if the handle is cracked or the head loose. Do not use a bar, wedge, or sledge having burs or splinters; give it to the toolman. Watch that your tools do not touch electric conductors. When carrying bars, pipes, or other material through doors be careful so as not to strike persons passing by. (See fig. 26.)

Avoid leaving tools, scrap, boards, lumps of ore or stone, or sheet iron, on the walks where they may cause some one to stumble, or fall into a bin or into the stock house. Coke forks or shovels should be placed with the edges or prongs pointing to the floor. Report to

FIGURE 23.—Trestle laborer using safety car wrench. When the shaft begins to revolve the hinged jaw releases. Disk is to prevent man's hand from striking car, short bend on end of handle is to prevent use of pipe extension.

your foreman any rotten, loose, or burned planks in the walks, or defective lights. When you are set at new work be sure to ask about the work, the way to do it, and the dangers connected with it. Do not ignore danger signs; they mean what they say. Do not wrestle or play when at the plant, especially when on the trestle where you may fall into a bin or the yard.

Men working in ditches and excavations should work far enough apart to avoid any risk of striking one another with picks or other tools. (See fig. 27.) Before leaving an excavation for the night or for other work cover the hole with planks. Manhole covers should

FIGURE 24.—Man crawling out of hopper car through doors; an unsafe practice. Do not get out of hopper cars through the doors.

FIGURE 25.—Trestle laborer in ore bin, wearing belt and life line.

always be replaced when a job is done, or even when leaving the job for a short time. (See figs. 28 and 29.) If you are chipping concrete, wear goggles, as chips frequently fly in the eye. Don't undercut piles of ore or stone, or piles of frozen earth, sand, or other material. Don't undercut banks when excavating; keep them knocked down; test the edges with a bar and knock or pry any loose earth down (fig. 30). Frozen ground is especially dangerous.

Stay out of cast houses, pig machines, boiler houses, and other places where your work does not require you to go, and keep away from iron and cinder ladles when they are being shifted. Whenever possible, keep from under cranes in operation. Always warn

FIGURE 26.—Workman endangers passer-by in carrying bar through a doorway.

the crane man before beginning to clean the tracks about the granulating pit, as he may accidentally drop some hot slag over the sides of the car unless he knows you are beneath, or scalding water may run from the grab bucket as it is carried over your head. Be careful in cleaning up about a loaded cinder car as steam and scalding water may escape suddenly from a drop door. Don't throw wet or damp rubbish into cinder ladles, as it may cause an explosion, and in turning a hose on a leaking cinder or iron ladle stand as far away as possible, as you may be scalded by steam or burned by an explosion or "shot" if the water hits molten iron. Avoid walking on ash piles; they may be hot underneath and burn your feet if you break through. Keep your feet out of flue dust when cleaning it up.

In loading or unloading cars, see that the gang planks or runways are in good condition and are properly placed and secured.

Be careful when handling heavy material or using tools (see figs. 31 and 32), as most accidents about blast-furnace plants are caused in such work. When necessary to go on a roof or window ledge to clean windows always use a safety belt and a life line. When cleaning windows from a ladder do not overreach; go down and move the ladder if necessary. Be sure that the ladder is resting

FIGURE 27.—Men standing dangerously close together while using picks.

squarely at the bottom so that it can not slip. If the ladder is a long one have some one steady it. Always have at the top a cross piece long enough to span the entire window. The cleaner you keep the yard the better and more safely everyone can do his work. Don't let piles of rubbish accumulate, or pieces of lumber, brickbats, scrap, and other material lay around, or leave tools about; some one may stumble over them. Fill up small holes and depressions and report promptly any steam or hot water puddles caused by leaky lines.

FIGURE 28.—Workman goes away and leaves manhole uncovered.

FIGURE 29.—Passerby falls into uncovered manhole.

If you make an opening or remove the cover from any opening in the floor, valve pit, or sewer, guard that opening so no one can fall into it.

PIG-MACHINE MEN.

Always wear goggles or a mask when working about the troughs while iron is being poured; be cautious when the molds are cold or if they have ice, snow, or water in them, and, especially when cinder is coming over, keep away as much as possible. When it is necessary to work under the strands to knock out the "stickers" keep from directly under the strand as much as possible, both the one you are working on and the adjoining strands. Men tending the lime vats and sprays should watch for stickers when it is necessary to go

FIGURE 30.—Man cutting too far beneath bank. Don't undercut piles of ore, stone, sand, or frozen material.

under the strands to adjust the sprays or to feed lime, while the machine is running. Aim to do such work between casts and shut off the steam when working about the sprays or vats. Before pouring examine the top of the ladle to see that there is no solid crust of cinder or iron frozen over the hot metal. Such crusts should be broken with a warm, dry bar as otherwise the metal will splash badly when it breaks through the crust. Never operate the motors, clutches, or hoists for pouring ladles or running the strands unless it is your job, or unless you are told to do so by the foreman. Keep away from around the sprocket wheels. Remove the scrap and

clean the rails between pouring ladles or casts. Don't try to save a few seconds by stepping on or across molds in motion or containing hot metal; use the walks or go around if necessary. Be sure that the bars you use to bar scrap out of the troughs with are dry and warm and avoid using short poling sticks. Before releasing the ladle after pouring replace all safety dogs or legs in position.

When you are working about the rear of the machine wear goggles to protect the eyes from flying chips of iron or lime dust. Use care in loading cars to prevent side loading, overloading, and loading

FIGURE 31.—Unsafe way of holding a bar for a sledge; man holding the bar is standing on same side as the striker.

directly upon drop doors, and see that no pigs are left on the end frames where they may fall off.

When working on the pig-machine strands, or changing molds, see that motor switches are locked open, tagged with a danger sign, or that the clutch is fastened open. Avoid touching electric lines, motors, or light sockets, for where there is so much steam and metal floors as about pig machines, you may get a severe electric shock or burn. Keep sledges, cutters, and other tools in good condition, be careful in using them, and watch your hands and feet when handling molds or pigs. Report cuts, burns, and bruises promptly.

LADLE-HOUSE MEN.

Don't leave large pieces of scrap on the ladle spouts, they may cause accidents in shifting or pouring, and in removing them use a long bar and keep away from in front of the ladle; work from the side. Before trying to remove a bottom skull clear away all overhanging rim or side skulls and knock out any loose bricks. The bottom skull will then come out more easily and safely. Before removing a skull or cleaning a ladle be sure the ladle is securely blocked

FIGURE 32.—Safest method of holding a bar.

or propped. When trying to lift a rim skull out of a ladle with the crane don't stand on the rim of the ladle, the hook may slip and strike you or cause you to fall. Watch all ladles for iron frozen on the rim or spouts, skulls, and "hot spots" or signs of failure on the lining whereby hot metal might break through. A thin place in the lining is usually shown by the ladle shell becoming rusty red.

Do not clean hot kish or metal from ladles onto damp ground; to do so may cause an explosion. When cleaning a ladle into the quenching pit use a long-handled scraper and keep as far back as possible. Take time to pull the cleanings out slowly and keep them

from running out suddenly if they start to slide. There is no danger of an explosion if the cleanings are fed into the water intermittently and in small quantities and not too fast. An accumulation of unquenched ladle cleanings beneath the water or a rush of cleanings may explode. To guard against sparks or small splashes wear goggles or a mask. When playing a hose on hot scrap or ladle cleanings stand as far away as possible to avoid steam or small explosions. If you dry ladles with gas, do not try to light the gas with a torch; kindle a small wood fire or throw burning waste on the ladle before turning the gas on. Always examine a relined and dried ladle that has been standing about before using it; if it seems to be damp inside, build a fire in it or dry it again. A damp lining will probably cause boiling, leaks, or explosions of hot metal. Always report water in cinder ladles.

Do not work inside of a ladle without notifying the crane man or placing a sign to show him you are inside, so that he will not carry loaded buckets over you. Use hooks or tongs in handling heavy pieces of scrap. Gloves or hand leathers, except safety hand leathers, should not be used, as they may catch and cause you to fall. In hooking on scrap to be lifted with the crane see that you do not catch your hand. When breaking scrap with a steel drop ball get behind shelter and place danger signs to warn others from flying pieces. In steadying heavy crane buckets use a hook or a long-handled shovel. Do not stand close where you may be crushed or caught between the bucket and some other object.

SLAG-DUMP MEN.

When dumping cinder ladles at dumps, pits, or conveyors keep away from the front, as the cinder will splash to a great distance. Never pour cinder on flue dust or refuse coal; to do so may cause a great burst of flame or an explosion. Never try to remove a "sticker" or apparently solid skull from a cinder buggy or ladle that has just been brought from the furnace to the dump; the sticker is probably molten inside, and if it does not fall out itself when the ladle is tilted and you try to pry it out it may burst and splash hot cinder on you. Before working on such a ladle report the sticker to the foreman. He will, if necessary, set the ladle aside long enough for the slag to harden, when it can be pried loose without danger from burns.

ENGINE ROOM FORCE.

Before changing blowing engines on a furnace first notify the furnace blower unless it is an emergency change on account of a breakdown. In case of a stop at the furnace keep at least one engine

turning over at sufficient speed to avoid any chance of its being stalled. Watch that the flywheel does not turn backward owing to the back pressure of the blast; few blowing engines will do this, however. By keeping an engine turning over against the butterfly valve in the cold-blast main with the snort valve open there is the least chance for an explosion or fire in the cold-blast main and air tubs.

In case two or more furnaces are blown from one room attach a number to each engine showing the furnace it is blowing to avoid any possibility of confusion in checking the furnaces. When the furnace whistle is blown for a check observe the signal light or number as well as the whistle before checking the furnace. In case of a shutdown when the engines are stopped close the stop valves between the air tubs and the cold-blast main. In case there is a steam connection to the cold-blast main examine the connections at the beginning of each turn or shift to see that both air and steam connections are in working order and that no steam is leaking into the main. Always be ready to turn steam into the blast main if the signal or word is given. Place numbers at each steam inlet to correspond to the furnace number. Always be ready to check the engines promptly; at times conditions at the furnace demand throwing the snort valve open very quickly and getting the wind off as fast as possible.

Before entering a cylinder to make repairs lock the steam throttle and the vacuum stop valves, place blocking in the cylinder, and block the flywheel fast. The drain valves should be opened prior to taking off the cylinder head. In undertaking repairs to gas engines be sure that the gas valves and water seals to the engine are closed. It is essential that two men should work together in repairing gas-engine parts that are inside the cylinder, are near gas or inlet valves, exhaust lines, or are in inclosed places, such as basements and tunnels. Be prompt in shutting down gas engines when the signal is given, as there is even more danger involved in delay with gas engines than with steam engines.

Oilers and wipers should wear closely fitting clothing that can not be easily caught in moving parts. In wiping and inspecting the engine watch that you do not get caught by rocker arms, wrist plates, eccentric rods, and Corliss or other valve mechanisms. Be careful that you do not slip on oily platforms and steps, and be prompt to report equipment out of order or in a condition dangerous to employees or the plant, such as valve wheels without lock nuts, steam leaks, worn or oil-soaked governor belts, broken steps or railings, defective indicators or gages.

Remember that uniform and correct speed of the blowing engine has much to do with the regularity of the furnaces. Irregular speed causes slips and other serious troubles. Report immediately to the

blower any trouble with the pumps and tuyère-water supply so that he may be prepared to take care of the furnace in case the flow of water becomes slack or fails.

Do not put any engine or machinery in motion without seeing whether anyone is in a position to get caught or struck. Do not work on electrical equipment or touch wires unless advised by the electrician. Let the electrician fix the lights. In working above be careful not to drop tools or leave them where they may fall on someone below. Keep from under loads carried by cranes. When the crane is being used one man only should have authority to signal the crane man to hoist. The crane man should try to hoist straight, but as the crane is usually high heavy loads may swing, so it is best to keep at a safe distance when he starts to hoist. Do not tighten bolts in leaking flanges on live steam lines except under the direction of the master mechanic. Be careful in placing a ladder before using it and if there is any danger of its slipping have someone hold it. Do not carry tools or material up or down a ladder; use a hand line (see figs. 8 to 10). Return mushroomed or burred chisels and other defective tools; report or remove rounded nuts and be careful not to use too large a wrench or one with spread jaws. Don't pull on a wrench when you are in such a position that you may lose your balance and fall if the wrench slips.

BOILER-HOUSE FORCE.

Always pay attention to furnace signals for checks, slips, and shut-downs and be sure to follow the plant rules for taking boilers off when the furnace is shut down; failure to do so may cause an explosion. When the furnace is hanging and liable to slip, and especially when one or more checks have been blown to slip the furnace, keep away from gas burners, firing and ash-pit doors, and explosion doors; the gas may flare out and burn you when the furnace slips. Do not sit on or near dust boxes, burners, or gas mains; a very small leak will let enough gas escape to "gas" you. Do not stay in any place where you can smell gas. If your work requires you to do so have a helper with you and be sure that your foreman knows what you are doing.

Do not go inside a boiler setting to make repairs or clean it until you have stopped with clay all gas leaks about the burners and mains near openings into the setting. If the burner or burner valve leaks and the burner can be pulled back put a piece of sheet iron between the nose of the burner and the setting. If the burner can not be pulled back put a blank flange in the downleg or other feasible place, unless the valve is absolutely tight. Do not enter the setting, boiler,

or work on the tubes until the foreman has either locked or placed danger signs at the gas burners, blow-off valves, and stop valves at the steam leader and feed lines. Wait until the clinker and dust has been cooled off, and have someone to watch you while inside and "spell" you off, before entering the combustion chamber. Don't stay inside when turning a hose on the walls to cool them, as the clinker is likely to spall off and expose red-hot dust or brick which may make the water boil and spit and scald you. Before opening manhole covers or tubes the safety valve should be lifted; be sure the steam is entirely exhausted from the boiler.

Unless it is your work and you are familiar with it, do not turn gas into the boilers after a shutdown unless the foreman is present. It may explode and burn you if it is not lighted properly. Similarly, do not turn steam into a cold line or put the boiler on the main steam line unless the foreman, water tender, or head fireman is present. Never open a burner or valve with a danger sign on it. If it appears that some one has forgotten to remove danger signs when through work, report to the foreman. Don't remove the signs yourself unless directed to do so.

To open a cold-steam line proceed as follows: First, open the valve drips; second, open the by-pass or open the stop valve enough to warm the line slowly; third, do not open the main-line valve until you are certain the line is heated. To turn the boiler into the main steam line: First, bring the boiler pressure to within 5 pounds of the main-line pressure; second, open the valve next to the boiler slowly; third, open the valve next to the main steam line slowly. To clean boilers: First, close all stop valves on the steam main (do not depend upon any automatic stop or nonreturn valve); second, close all valves between the mud drum and the blow-off main; third, if there is but one valve, put a blank flange between the valve and the boiler; fourth, close the stop valves on the feed water next the main line and next the boiler; fifth, close the stop valves on the feed water next the main line and next the boiler; sixth, place danger signs at the valves and lock them; finally, be sure the steam is entirely out of the boiler.

In removing and replacing gage glasses wear heavy goggles. When turning water into a gage glass place a shield in front of the glass to protect yourself from glass or steam should the glass break, and turn the steam in slowly. Leaks in pipe flanges and gasket or valves should be promptly reported. Never use a hammer, chisel, or wrench on live-steam lines in an attempt to temporarily stop leaks. Watch your steam hose and replace it when it shows weakness. In blowing off boilers open and close the blow-off valve slowly.

In unloading ashes be sure that they are wet down, and in turning water on them do not get close enough to be burned by steam. When unloading coal wet it down, if very dry or dusty. Never use any kind of a light other than an electric light when working about dusty coal, and do not smoke. Neglect of this precaution may cause a violent dust explosion.

RIGGERS, MILLWRIGHTS, AND HANDYMEN.

Don't go on top of the furnace unless you notify the furnace foreman, so that you will not be on top when the furnace is liable to slip. Also notify your foreman so that he can send someone with you. One man should always stay where there is no gas, but in a position to watch the other man while he is inspecting or oiling. If the latter appears to be getting "gassed," the alarm should be given the stock-house or cast-house crew, and every effort made by the watcher to get the exposed man out of the gaseous place, or to keep him from falling while the crews are coming up. Do not go over the receiving hopper unless you notify the skip or bell operator not to operate the bells. Avoid making even routine examinations of hoppers and bells unless the furnace foreman knows that you are doing it and upon what particular top or furnace you are working. Repairs to explosion doors or bleeders or work inside of hoppers should never be undertaken when the wind is on. At shutdown don't light the gas on top of the furnace until you have received the signal from the blower.

Before going into gas mains, scrubbers, or any inclosed gas-containing or gas-using place to make repairs or inspections, be sure that every gas connection is closed and the place cleared of gas. Familiarize yourself with the layout of gas valves, water stops, and gas mains, so that you may know where all gas connections are. Always wait until your foreman and the furnace foreman say it is safe to go in. In closing and opening sand, goggle, or slide valves watch for gas. When it is necessary to work in gaseous air, as it often is to make some other place safe, to shut down or start up a furnace, or other reason, work in "spells," and if you feel sick or dizzy go into fresh air at once. When possible, always wear breathing apparatus or a belt and life line, both in inclosed and uninclosed gaseous places. Avoid smoking in such places.

When it is necessary to examine a chimney valve on a stove notify the stove tender not to shut the blast off or turn the gas on. Before examining hot-blast valve slots or valves see that the gas is shut off and the chimney valve is open. Do not go inside of a hoist drum to replace or take up the hoisting cable until you have seen for yourself that the steam-stop valve is shut and the pinion blocked in the

gear, or, if it is an electric hoist, that the motor switch is locked open and the gears blocked. Avoid trying to adjust the feeding or running on of cables on wrenches or hoist drums while they are in motion. Do not work on cranes, hoists, skip inclines, skip pits, and scale or lorry cars unless you know that the motor switches are locked open. When on crane runways be sure the main-line switch is open, or if the crane must be used protect yourself with track torpedoes. When pouring hot babbitt or lead warm the sockets or molds, and wear goggles to protect your eyes from splashes.

Before going on scaffolding, inspect it and satisfy yourself that it is safe. Don't lean castings against scaffold uprights or pile material against them. When placing material upon scaffolds let it down carefully, don't throw it down or let it drop quickly, especially if lowering it with a winch or hoist. Place material evenly and look out for overloading. On coming down from scaffolds or platforms don't slide down ropes; use the ladders or steps provided. Never throw tools or other materials down from scaffolds unless the space below is protected with danger signs or a watcher. Do not leave bolts, rivets, tools, etc., on platforms when through work or lay them during the work where they may fall through holes or from the edge of the platform. (See figs. 33 and 34.) Remember to use care when on ladders.

Do not attempt to tighten or adjust doors, nuts, valves, or packing glands while the blast is on, and avoid rushing repair jobs by loosening too many nuts or keybolts on blast mains, hot-blast valve seats, or heads before the blast is off. Ascertain the correct number to loosen and do not exceed that number.

Where hoisting tackle is used the danger of practices such as walking near taut hoist lines, getting foul of guy lines, standing in front of snatch blocks (fig. 35), etc., may not be apparent to laborers or members of the furnace crew who are helping. You can prevent accident by warning the men of these obscure dangers. Be sure that all hoist lines, cables, chains, tackles, and boatswain's chairs are in good shape before using them. Care should be taken in slinging a load to see that the slings are properly arranged and the load balanced and securely fastened to prevent slipping. The part of the sling from the hook to the load should be long enough so that it makes an angle of more than 45° with the ground. Very short and flat slings are under much greater stress than ones arranged as above. In hooking on the load watch that your hand does not get caught, and don't grab the cable above the lower sheave block.

Be sure to replace all belt, gear, machine, and engine guards, shields, and railings; they prevent accidents. Do not try to do work on electrical wires or to connect temporary lights. Defective in-

FIGURE 33.—Workman places wrench carelessly on ladder platform.

FIGURE 34.—Wrench falls and injures helper. Don't leave tools or material lying in such position that they may fall on anyone.

sulation may cause a severe shock or burn, especially if you should be standing on an iron plate. Keep your tools in good shape and return all tools with burrs or mushroomed heads, cracked handles, or other defects for redressing and repairs. Avoid using pipe wrenches, defective wrenches, or a wrench that is too large for the bolt head or nut to be removed. The wrench may either slip or round off the nut.

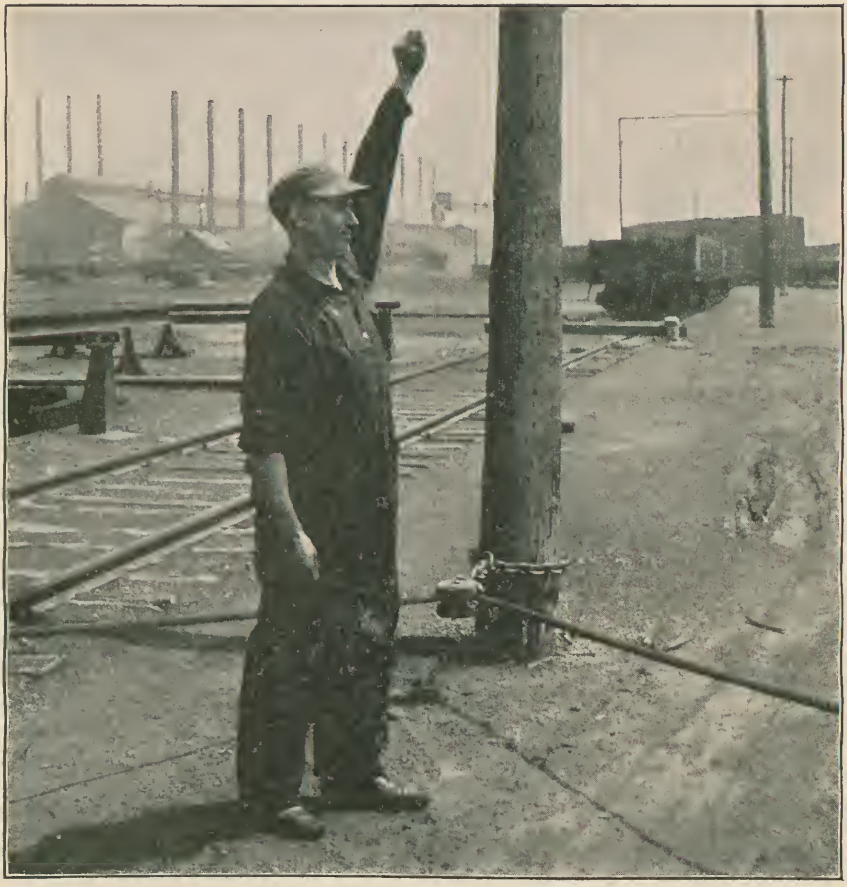


FIGURE 35.—Careless workman standing inside of cable bent around a snatch block. Don't stand inside of the angle of a line or cable passed through a block.

Be especially careful in working on rounded nuts and replace them with new ones at the first chance. Don't cut rivets, bolt heads, or nuts off until you have placed a shield to prevent them from flying, or have a sign or a watcher to warn men of the danger. When clipping or cleaning castings always wear goggles. (See figs. 36 and 37.)

Regular inspection of hoists and skips, brasses, bells, sheaves, hoppers, and valves may prevent sudden shutdowns and extra hazard-

ous work. Members of rigging and millwright gangs, being in every part of the plant in their regular work, should know more about many obscure and not readily apparent dangers than most

FIGURE 36.—Workman wearing goggles when grinding tools. Note the guarded emery wheel.

of the furnace force. It should be a part of their duty to report any dangerous practice or condition. There are many trivial sources of accidents, so many that no one man or committee can see them all, or, in some cases, even know that they exist until injury results.

PIPE FITTERS AND TUYÈRE GANG.

Do not go up on the bustle pipe or stack platforms until you have notified the blower, keeper, or stove tender. When going above the bustle pipe it is safest to have a watcher. Before repairing sprays on dust catchers or on skips, skip-pit siphons, steam, air, or oil lines on top of the furnace, or sprays on the furnace jacket, notify the furnace foreman as it may be necessary to stop charging or to check the furnace. When changing bronze, make all plate, tuyère, and cinder-notch water connections before the blast is turned on.

FIGURE 37.—Workmen cutting rivets. Note shield, also use of goggles.

Leaking steam, where the men have to work, is always annoying and is frequently a menace on account of the noise and the mist, and the possibility of scalds. You can do much to prevent the danger from this cause by promptly attending to the leaks. Warn other men of the danger of attempting to stop steam leaks on pipes under pressure by tightening flanges.

A blast-furnace plant is different from other plants in that, if an emergency requires a quick shutdown, the operation may be very hazardous, unless everyone knows what to do and does the work

assigned to him promptly and accurately. Make it your first duty to learn the layout of the water and the steam lines so that in an emergency you will know what to do. The safety of the plant may depend on the working of the steam lines leading to the gas mains, and the water lines leading to the water-seal valves. It is up to you to see that these lines are always in working order. Try them frequently by testing the steam line to the main for gas, and, if the line is plugged, clean it. Try the lines from the water and also from the steam supply for delivery; keep them drained to prevent freezing, and be sure the valves are not stuck. Do not let the water collect in the water-seal valves.

Successful and safe furnace operation depends in part upon the cooling-water system being kept in proper condition. Careful testing of tuyères, coolers, plates, regularity in flushing the mud and sediment out, and regular inspection of the strainers, will do away with much of the disagreeable, difficult, and, at times, dangerous work caused by chilled or slipping furnaces, "messes," and bursting tuyères due to water leaks.

BRICKLAYERS.

Inspect a scaffold before going up on it, and do not let your helpers or laborers go up unless you are satisfied that the scaffold is safe; many of them probably do not know whether it is safe or not, and must rely upon your judgment. In piling brick on a scaffold be careful not to overload it. Don't permit your helpers to drop the bricks on the flooring; make them set the bricks down carefully, and don't let buckets of clay or loads of bricks down heavily. Avoid overloading the hoist buckets, so that the material can not fall off; use safety hooks for hoisting buckets and pails. Don't throw brickbats down promiscuously when you are on a repair job; rope off a danger place, and place a danger sign to warn the men. Be careful not to leave your tools or bricks where they can be easily dislodged and fall, whether there are men below or not.

Before going into inclosed places where gas has been used or contained satisfy yourself that the gas valves are tightly shut. Remember that in such places there is always an odor of gas unless ventilation is very ample and pronounced. It is sometimes necessary to go into these places, and although you may feel assured that there is no gas leak, come out at once if you begin to feel dizzy or ill. Gas may come from old brickwork, flue dust, bulkheads, or wet surfaces in amount sufficient to overcome you, and when ventilation is difficult the slightest odor of gas is a warning for you to exercise the greatest caution. Always wear a belt and life line and a breathing apparatus where ventilation is weak or lacking and there is reason

to expect gas. Use electric lights when working inside gas mains; torches make the air unfit to breathe. Use goggles when you are cutting brick, and if you get a bruise, abrasion, or laceration report it at once.

CARPENTERS.

It is your duty to use sufficient and strong enough lumber to make every scaffold, staging, railing, gangway, and ladder safe. The men may not know whether they are safe or unsafe; but whether they are competent or incompetent to judge, you can not evade responsibility for unsafe construction. Temporary ladders, runways, and other wooden constructions not intended for permanent use often are used when they have become unsafe. Make it your duty to condemn any unsafe equipment of this kind and to promptly remove temporary scaffolds or ladders when the need for them has passed.

Avoid leaving lumber with projecting nails about the plant, and hammer flat or remove all projecting nails that you notice on scrap lumber or lumber used in construction. (See figs. 38 and 39.) In laying planks for temporary floors, walks, or runways place the ends so that men in stepping on them will not tip the planks up.

Most of the accidents that happen to men doing carpenter work are caused by their hitting themselves with hammers and hatchets, from saws slipping, and in handling lumber. In working on lumber piles watch that you do not fall. In handling rough, heavy, or splintered lumber be careful not to drop it on your hands or feet or lacerate your hands. Be watchful and careful in the use of hand tools, and observe danger signs and the directions and warnings of foremen and men acquainted with the dangers at the different parts of the plant. By so doing a large proportion of the injuries commonly encountered will be avoided.

ELECTRICIANS.

The insulation on electric wires and on tools and rubber gloves can not be depended on to prevent shock, as the insulation may not be in good condition. Do not work on live circuits unless absolutely necessary, and if necessary and you are in doubt as to the voltage of the circuit, consult the foreman and obtain his permission.

Try to observe the following precautions: Use only one hand if possible (figs. 40 to 43); work on only one wire at a time and insulate it before starting on the next one; insulate parts of opposite polarity within reach of tools; do not touch electric conductors when you are standing on iron plates, structural iron, wet ground, or pavement—get a dry board or rubber mat to stand on; use tools with the

FIGURE 38.—Workman throws down board with nails in it.

FIGURE 39.—The result. Boards with nails sticking in them should not be left lying around.

handles adequately wound with tape, and wear rubber gloves without cracks or holes.

Take the same precautions with supposedly dead circuits, as there is always a chance of such circuits being crossed with a live circuit. Low-voltage systems, telephone wires, and signal wires may similarly be crossed with high-voltage lines.

When power has been cut off by opening a switch place a danger sign bearing your name on the switch and lock it open. Do not remove the sign and lock unless the work is completed, everybody and everything clear of the circuit, and no one in a position to be injured by the machinery starting up. Do not attach wire or cord for lights to iron pipes or structural parts. Neglect of this precaution may lead to charging of equipment or parts so that a man may receive a shock when least expected. Make frequent inspection of flexible cord for hand lights, portable clusters, or electric drills. The various crews frequently handle them when standing on wet places where, should the insulation be defective, a serious burn or shock might result.

Remove all dead circuits not likely to be used. Avoid installing temporary wires in a slipshod manner. Do not let inexperienced men handle electrical equipment, and do not set bad examples of careless familarity with electrical equipment for inexperienced men to follow. Always attend immediately to an electric burn. Such burns are often misleading; a third-degree burn which may not be immediately painful may later result in gangrene.

Familiarize yourself with the methods to follow in case of an electrical shock to an employee, as described in Miners' Circular 23.[a]

CRANEMEN.

Never carry a load over a workman's head. If men are working in the path of a load, run the trolley out to avoid them, or give them warning. Before moving a crane be sure that no one is in a position to be injured. Open the main switch before leaving the cab, and do not go or allow another to go on top of the crane runway without opening the main-line switch and attaching to the switch a notice bearing his name. If the switch is found open and no notice on it, notify the foreman instead of shutting it yourself; there may be a reason for its being open.

Do not hoist without a signal when men are hooking on or slinging material. If possible be sure that their hands are not inside the hook or sling. Place the trolley directly over the load to avoid swinging it against the workmen. In hoisting heavy loads test the brake when the load is a few inches clear of the floor.

[a] Lynott, W. A., and Harrington, Daniel, Elementary first aid for the miner: Miners' Circular 23, 1916. (In press.)

After a repair job is finished go over the crane carefully and pick up any tools, bolts, or parts left behind. Watch for loose parts; see that the brakes, warning bells, and switches work properly and report at once insecure or dangerous parts or places. Don't leave chains, hooks, or buckets hanging at heights that do not clear a man's head.

FIGURE 40.—Safe way to open a switch. In handling any circuit known to be alive, wherever possible use only one hand, keeping the other behind the back.

NOTES ON FIRST AID.

In plants where the continual presence of a doctor or nurse is not feasible it is advisable to have at least one emergency first-aid box. These boxes are furnished by various manufacturers and associations and contain materials designed or recommended by advisory boards of physicians and by the American National Red Cross. They are admirably adapted for use at isolated plants and primarily are for the prevention of infection. A first-aid box in the charge of the chemist, storekeeper, or watchman will encourage the workmen

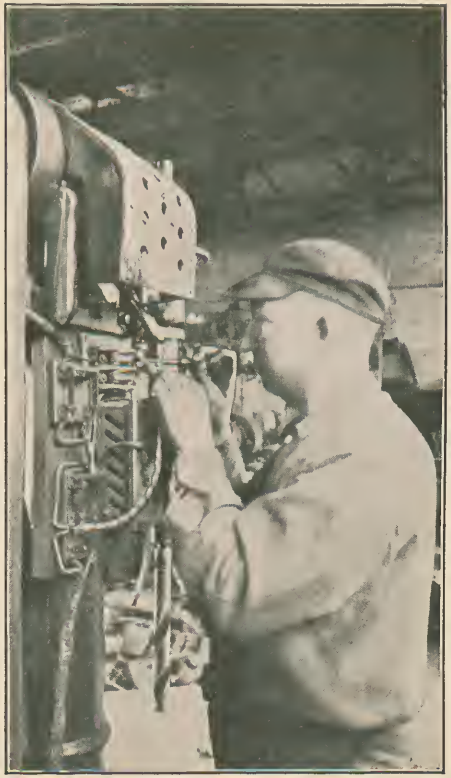


FIGURE 41.—Electrician repairs wire with the switches in; a dangerous practice.

FIGUGE 42.—Result of repairing wire with switches in; short circuit burns electrician.

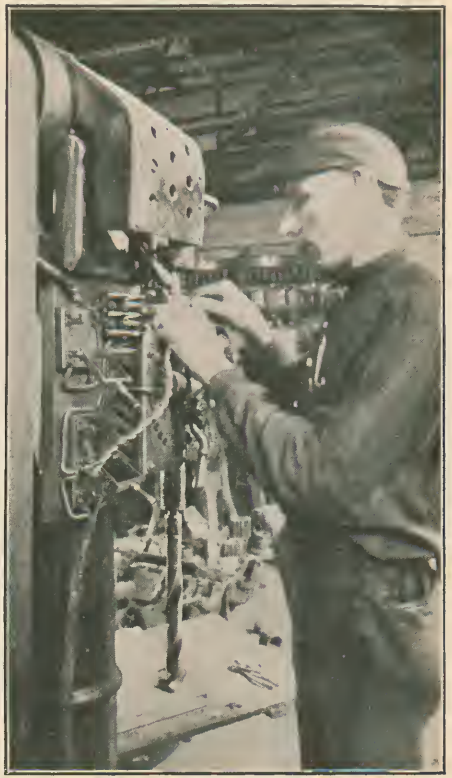


FIGURE 43.—The safe way to repair a wire, switches out.

to form the habit of seeking immediate first-aid treatment for slight injuries. Such treatment, if correctly performed, may prevent infection or illness, but further treatment should be by a physician.

When a man is so badly injured that he needs immediate relief before a physician can arrive or before he can be taken to the first-aid room it is essential that some one with a knowledge of first aid should assume charge, preferably the foreman, first-aid man, member of safety committee, or ranking employee and direct the work of caring for the injured man until the doctor arrives.

TRANSPORTATION OF INJURED.

Do not move an injured person or move any part of his body until you are sure of the nature of the injury. If the injured man is unable to walk use the greatest care in placing him on the stretcher. Stretchers are now so universally available at plants that mention of other means of carrying men should be unnecessary; however, familiarity with methods of handling injured men is essential.

EYE INJURIES.

Any object in the eye that irritates the lid or eyeball probably makes a cut which may be infected just as easily as a cut on the hand or foot, and more so if a toothpick, match, knife, or handkerchief is used to remove the object. Moreover, infection of a wound in the eye is a very serious matter, because the eye is the most delicate external organ of the body. If any injury to the eye is neglected or wrongly treated, not only may the eye become inflamed, involving loss of time, but the sight may be lost. If you get something in your eye, do not try to remove it from the eye at your working place; go to the first-aid station and have your eye examined at once. If the object can not be removed by cotton rolled on the end of a match or toothpick or by a loop of sterile horsehair, it is probably imbedded in the eyeball or eyelid, and the injury should be examined by a physician immediately.

CUTS, LACERATIONS, AND PUNCTURES.

Whenever the skin has been cut accidentally, it is safe to assume that germs have been introduced, because tools, clothing, or other material, the dust in the air, or the skin itself may carry disease germs. Every wound should be primarily looked upon as infected and receive immediate attention. A fresh cut should not be washed, even by the first-aid man; leave that for the physician. Unsterilized water is dangerous, for it may contain infectious germs. For the same reason waste, cobwebs, tobacco, or dust should not be put on a wound, nor should the open wound be touched with the fingers.

If a fellow workman gets hurt and the wound bleeds profusely, or in spurts, apply a tourniquet or constrictor and notify the first-aid

man. Immediate first aid by fellow employees is imperative in such cases, as the man may bleed to death before the first-aid man can arrive. A belt, suspender, handkerchief, rope, or any immediately available material that can be tied with a knot and twisted will do for a tourniquet. The man should be made to lie down and the injured part be kept elevated as high as possible by some one. If a limb is crushed or badly mangled, the tourniquet should be placed above the knee or elbow, near the crotch or arm pit, and twisted until just enough pressure is obtained to stop the blood. Every 20 or 30 minutes the tourniquet should be loosened a little; if bleeding recommences, it should be tightened again. If the circulation is stopped completely for upwards of three hours gangrene may develop. Many severely bleeding wounds may be stopped simply by pressure in the wound with a clean bandage. Details of methods of applying tourniquets and bandages are given in Miners' Circular 23.[a]

Puncture wounds, such as are caused by nails, slivers, and small sharp objects are perhaps the most dangerous of all small wounds. Such cuts are always larger on the inside than on the outside on account of the elasticity of the skin, and the danger of infection is greater because the puncture closes, little bleeding occurs, and there is less chance of any dirt and germs that may have gotten into the wound being flushed out by the flow of blood. Puncture wounds of the foot, and the palm of the hand, the thumb, and the little finger are especially dangerous.

BURNS.

A burn is not readily infected when first inflicted unless it has been broken open accidentally or by careless or improper handling. A burn should not be washed by anyone except the physician. For small burns picric-acid gauze or sterile gauze with vaseline spread on it, placed over the burn and fastened with a roll bandage, is efficacious. The use of carron oil, which is a mixture of linseed oil and lime water, is not recommended. Soda and sterilized water may be used, but is not as soothing to burns as picric acid.

When a large burn is caused by clothing ignited from hot metal or cinder, or by electric flashes, steam, or boiling water, it is better not to remove any but the outer clothing. The injured man should be handled as little and as carefully as possible. It may be necessary to cut away part of the clothing, such as a sleeve or trouser leg. In case medical or hospital attention is not immediately available, the entire burned area should be covered with picric-acid gauze or vaseline-covered gauze. If a hospital is near, the clothing may be satu-

[a] Lynott, W. A., and Harrington, D., Elementary first aid for the miner: Miners' Circular 23, 1916. (In press.)

rated with a soda and water solution (one-fourth pound soda in a half gallon of clean water). After such treatment, the injured person should be wrapped closely in a blanket.

All burns should be reported immediately to the foreman or first-aid man. Sometimes a second or third degree burn—that is, one in which the inner and outer skin, or skin and flesh beneath, are destroyed—may not, although a serious burn, be immediately painful, but later may lead to gangrene.

FRACTURES.

For the purposes of first aid, fractures may be classified as "simple," when the broken bone does not come through the skin, and "compound," when the broken bone sticks through the skin. Unless a broken limb is handled carefully a simple fracture may be converted into a compound fracture; therefore, a man with a fracture should not be moved until a splint has been applied. A compound fracture requires a longer time for recovery than a simple fracture.

A splint is simply a light stick or piece of wood for keeping the injured part in a fixed position by means of bandages. A broken arm or leg can be placed in a straight position, and if no splint material is available, a coat may be rolled from each side toward the center over the sleeves, placed about the broken limb, and tied there. An injured arm may then be tied to the body or a broken leg to the uninjured leg.

In case of a broken back, neck, or severe crushing and internal injury a patient should not be lifted until a physician comes. Unnecessary handling is harmful, causes needless suffering, and as a physician is generally immediately available at furnace plants, first aid in such cases is, as a rule, of questionable value. The patient may be kept flat on his back and covered with a warm blanket.

BLOWS ON THE HEAD OR ABDOMEN.

When a man receives a blow on the head or abdomen, first aid is not usually possible. Avoid rough handling, loosen the clothing, do not give liquid stimulant, and call a physician at once. Don't let the patient go home alone. After receiving a severe blow on the head men have continued work, or stopped work for the day, and then suddenly became seriously ill or died. Similar developments are possible after a heavy blow on the abdomen.

BRUISES AND STRAINS.

Such injuries as bruises and strains should always have the attention of a physician rather than first aid only, for although the injury may at the outset seem very slight, it may develop into a deep-seated injury with permanent total or partial disability.

ASPHYXIATION OR SHOCK.

To remove a victim from contact with an electric circuit, cut the current off if there is a switch handy. If not, roll or push the man's body from the circuit with a dry piece of wood or wrap your hands

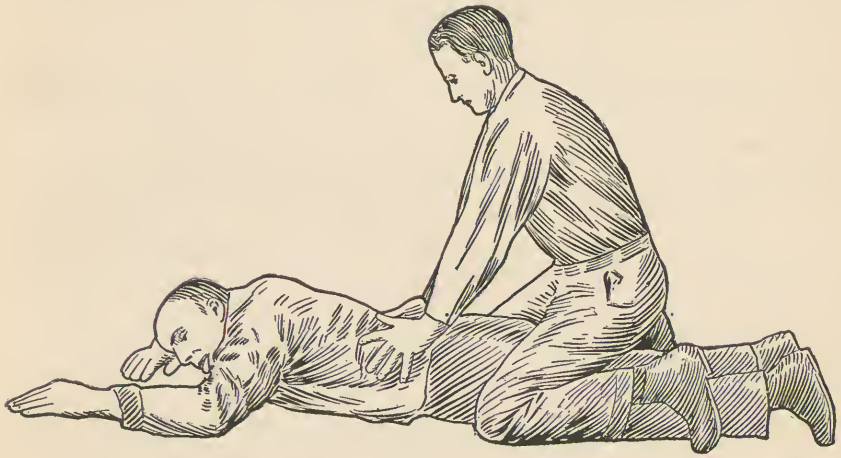


FIGURE 44.—Schaefer method of artificial respiration. Expiration.

in a dry cloth and stand on dry wood, grasp his clothing and lift his body from the wire, or place a loop of dry cloth or rope over the man's head or feet and jerk him from the wire.

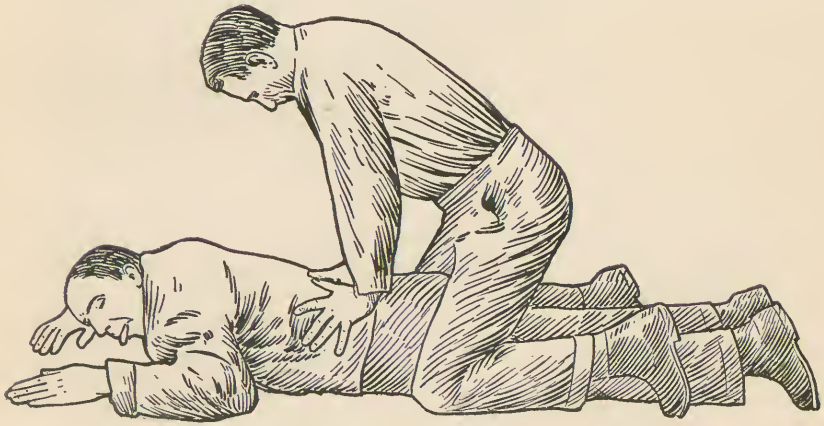


FIGURE 45.—Schaefer method of artificial respiration. Inspiration.

In case a man has been asphyxiated or "gassed" or has received an electric shock, carry him into the open air, send for a doctor, and then proceed as follows:

Feel with your finger in his mouth and throat and remove any false teeth, tobacco, etc. Lay him face downward, with one arm extended out straight beyond his head. Place his other arm under his

head, and turn his face to one side, so that mouth and nose are free for breathing. Have someone draw his tongue forward. Put a folded jumper or coat under the lower part of his chest if he is thin. Straddle him on your knees, facing his head (see fig. 44), with your knees a little below his hips; then with fingers outstretched place your hands at the lower part of his ribs with your thumbs nearly joining.

Hold your arms straight and rigid, swing forward slowly so that the weight of your body is gradually brought to bear on the subject's body; then swing back, removing the pressure, but keep your hands in place; repeat 16 to 20 times every minute. (See figs. 44 and 45.) If you have not a watch, follow the rate of your own deep breathing. Keep it up for 3 hours unless natural breathing is resumed. Keep the man warm and do not try to give liquid stimulant until he is conscious and able to talk and drink. Do not hold ammonia bottles under his nose or mouth.

It is important that every foreman and every member of a safety committee in the plant should understand this method of resuscitation.

For details of first aid, bandaging, use of splints, stretcher work, and methods of resuscitation, see Miners' Circular 23.[a]

[a] Lynott, W. A., and Harrington, Daniel, Elementary first aid for the miner: Miners' Circular 23, Bureau of Mines, 1916. (In press.)

PUBLICATIONS ON MINE ACCIDENTS AND METHODS OF METAL MINING.

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INDEX.

A.

Page.

Abdomen, blows on, treatment for__ 66, 67
Accidents, at blast furnaces, causes of__ 4, 5, 9–12, 16, 24, 25, 33, 43
due to unsafe practices, percentage of _____ 6
prevention of,_____ 3, 4, 7, 8
suggestions for, prizes for_ 7
responsibility of foremen for_____ 4
reporting of, need of_____ 10, 20, 46
See also Hand-labor accidents; Ore buggies, accidents with; Tools, accidents from.
Asphyxiation, treatment for_____ 67

B.

Bars, carrying of, method of, figure showing _____ 42
holding of, methods of, figures showing_____ 46, 47
Blast furnace. *See* Furnace.
Blast-furnace plants, accidents in, causes of_____ 4, 5, 9–12, 16, 24, 25, 33, 43
hazard at_____ 11
inspection of _____ 6
safety rules for workmen in___ 13–21
Blows on head and abdomen, treatment for_____ 66, 67
Boilers, cleaning of, safety rules for_____ 51
Breathing apparatus, use of_____ 52, 58
Bricklayers, safety rules for_____ 58, 59
Bruises, treatment for_____ 67
Burns, care of_____ 61, 65, 66
frequency of, at blast-furnace plants _____ 9, 10

C.

Cables, danger from, figure showing_____ 55
Carpenters, accidents to, causes of_ 59
safety rules for_____ 59
Cars, climbing between, danger of, figure showing_____ 14
hopper, improper exit from, figure showing_____ 41
unloading of, care in_____ 38
riding on, methods of, figures showing _____ 15
placing of, use of pole for, figure showing_____ 38

Page.

Cast house, clothes worn in, figure showing _____ 21
Casting, safety regulations in_____ 21–32
Clay, wet, in casting, cause of explosion _____ 25, 27
Clothes, style of, for blast-furnace work, description of____ 21
fiure showing _____ 21
Cranemen, safety rules for_____ 61, 62
Cuts, treatment for_____ 64, 65
Cutting beneath bank, danger from, figure showing_____ 45
Dust catcher, care of, safety rules for_____ 35

E.

Electric insulation, defective, results of_____ 55, 59, 61
Electric lights, use of, around dusty coal_____ 52
in gas mains_____ 59
in stove cleaning_____ 34
Electric shock, danger from_____ 20, 46, 53–55, 59, 61
treatment for_____ 21, 37, 67
Electrical repairs, making of, figure showing _____ 63
Electricians, safety rules for_____ 60, 61
Engines, blowing, safety rules for__ 48–52
cylinders of, warning men from, figure showing_____ 13
English language, knowledge of, need of_____ 20
Explosions, causes of_____ 20, 25, 27, 29, 32, 33, 35, 48, 51
Eyes, injury to, care of_____ 64

F.

Falls of persons, percentage in blast-furnace accidents_____ 10
First aid, for asphyxiation_____ 67
for blows on head and abdomen_ 66
for burns_____ 61, 65, 66
for cuts, lacerations, and punctures _____ 64
for eye injuries_____ 64
for fractures_____ 66
for transportation of injured__ 64
First-aid box, need of_____ 63, 64
First-aid instruction, need of_____ 6, 7
Flying and falling objects, accidents from, percentage of_____ 9, 10

Page.

Foremen, committee of, duty toward accident prevention by— 7, 8
responsibility for accident reduction — 4
selection and duties of— 4, 5, 9–12
warning men of danger, figure showing — 13
Fractures, first-aid treatment for— 66
Furnace, blast, blowing of, danger from — 22, 33

G.

Gas, cause of asphyxiation— 20, 50, 52, 58
cause of explosion— 33
Gate, punch out, operating of, figure showing— 25
runner, operating of, figure showing — 26
Gloves, for blast-furnace work, wearing of— 17, 20, 21, 24, 48, 59, 61
Goggles, for blast-furnace work, figure showing— 56, 57
wearing of— 11, 21, 24, 29, 34, 36, 42, 45, 46, 48, 51, 53, 59

H.

Hand labor, accidents from, percentage of— 9
Hand leathers, for blast-furnace work, figure showing— 17
wearing of— 17, 21, 24, 48
Hazardous operations. *See* Accidents.
Head, blows on, treatment for— 66, 67
Hot-blast men, safety rules for— 32–34

I.

Inspection committee, recommendations of, approval of— 8
selection and duties of— 5–7
Inspectors, safety, duties of— 5

L.

Ladders, carrying bucket on, figures showing — 18
safeguards for— 19
Ladles, cleaning of, care in— 47, 48
filling of, danger from, figure showing — 19
Ladle house, safety rules for men in— 47, 48
Leggins, for blast-furnace work, wearing of — 11, 24
Life line, wearing of, figure showing— 41
need of— 34, 38, 43, 58
Lights, electric, use, around dusty coal — 52
in gas mains— 59
in stove cleaning— 34

M.

Page.

Machinery, defective, reporting of— 32, 35, 36, 49, 62
Management, plant, duty of, relative to safety conditions — 3
Manhole, uncovered, danger from, figures showing — 44
Masks, wearing of, in blast-furnace work — 21, 45
Master mechanic, responsibility of, for safeguards — 9
Metal. *See* Casting.
Millwrights, safety rules for— 52–56

N.

Nails, in boards, danger from, figure showing— 60

O.

Officials. *See* Management, plant.
Ore buggies, accidents with— 36

P.

Picks, danger in use of, figure showing— 43
Pig machines, handling of, safety rules for— 45, 46
Pinch bar, use of, care in— 37, 38
figure showing — 39
Pipe fitters, safety rules for— 57, 58
Prizes, for prevention of accidents— 7

R.

Respiration, artificial, method of, figures showing — 67
Riggers, safety rules for— 52–56
Rubbish, care of— 14, 22, 32, 40, 42, 43, 47

S.

Safeguards, for ladders — 19
installation of — 8
use of — 3, 4, 20, 24
See also Gloves; Goggles; Hand leathers; Life line; Masks; Safety belt; Shields; Tongs.
Safety, insistence on, effect of— 3
Safety belt, use of— 43, 52, 58
figure showing — 41
Safety rules, for blast-furnace plants— 13–21
for bricklayers— 58, 59
for carpenters — 59
for cast-house crew— 21–32
for cleaning boilers— 51
for cranemen— 61, 62
for dumping slag— 48
for dust-catcher men — 35
for electricians— 60, 61
for hot-blast men— 32–34
for pig machines— 45, 46

Page.

Safety rules for ladle-house men 47, 48
for millwrights 52–56
for riggers 52–56
for running of blowing engines 49–52
for scale-car operators 36
for stock-house crew 35–37
for stove cleaners 34
for trestle men 37–43
for yardmen 37–43
Safety work, organization of 3, 4, 5, 9
Scaffolds, inspection of 11, 53, 58, 59
Scale-car operators, safety rules for 36
Schaefer method of artificial respiration, figures showing 67
Scrap, at foot of ladder, danger from, figure showing 13
cold, cause of explosion 27
Shield, for blast-furnace work, figure showing 57
wearing of 24, 29
Shock. *See* Electric shock.
Shoes, style of, for blast-furnace work 11, 17, 21
figure showing 16
Signals, giving of 33, 35, 37, 49, 61
Signs, danger, observance of 20, 40, 59
placing of 11, 32, 39, 53, 58, 61
removal of 51
Slag, dumping of, safety rules for 48
Steam, danger from 29, 52, 57
Stock house, crew of, safety rules for 35–37
Stoves, cleaning of, safety rules for 34
Strains, treatment for 67
Stretchers, use of, in carrying injured workmen 64

Page.

"Suggestion box," use of 7
Superintendent, furnace, recognition of safety work by 3
Switches, opening of, figure showing 62

T.

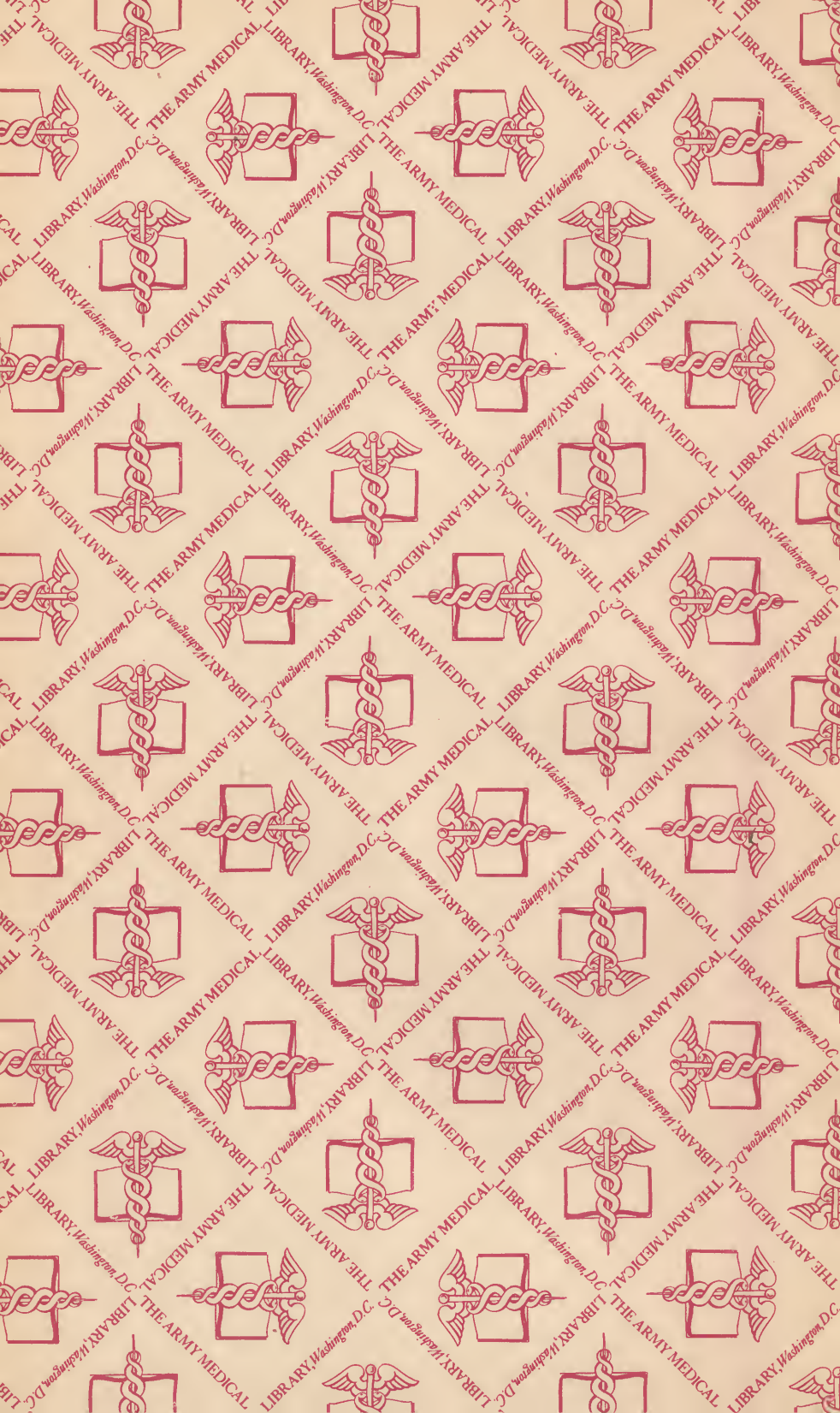
Tapping bar, wrong use of 24
Tapping hole, drilling of, figure showing 22, 23
stopping of, figures showing 28
Tongs, for blast-furnace work, use of 24, 29, 48
Tools, accidents from, percentage of 9
care of 11, 14, 19, 22, 40, 46, 50, 53, 55, 62
dropping of, danger from 19, 22, 40, 50, 53
figures showing 54
carrying of, method of 34
Trestle men, safety rules for 37–43
Trough, hot, wetting down of, figures showing 30, 31
Tuyères, bursting of, danger from 21, 23, 29
handling of, safety rules for 29, 57, 58

W.

Wounds, puncture, care of 65
Wrench, use of, figure showing 40
dropping of, danger from, figures showing 54

Y.

Yardmen, safety rules for 37–43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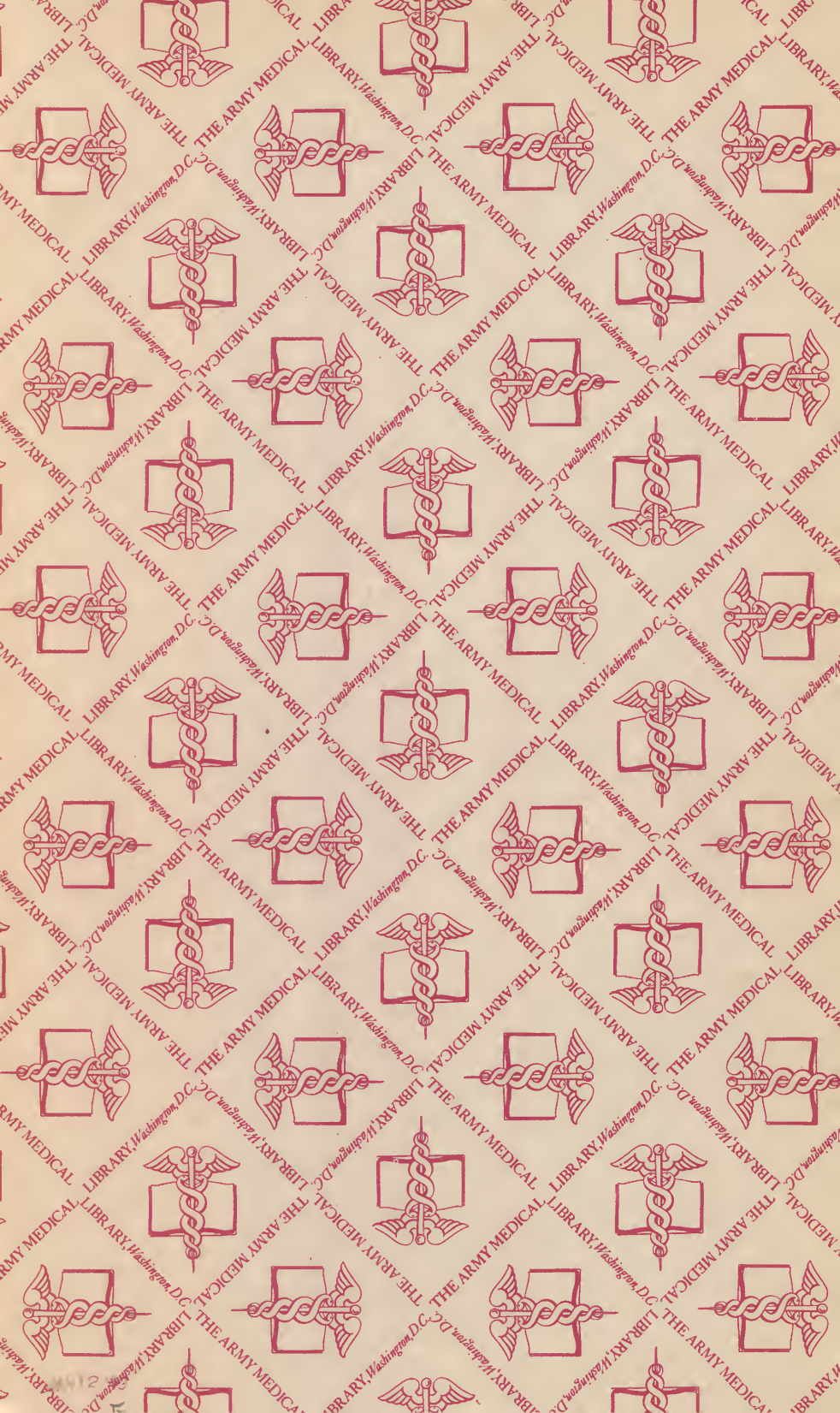
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